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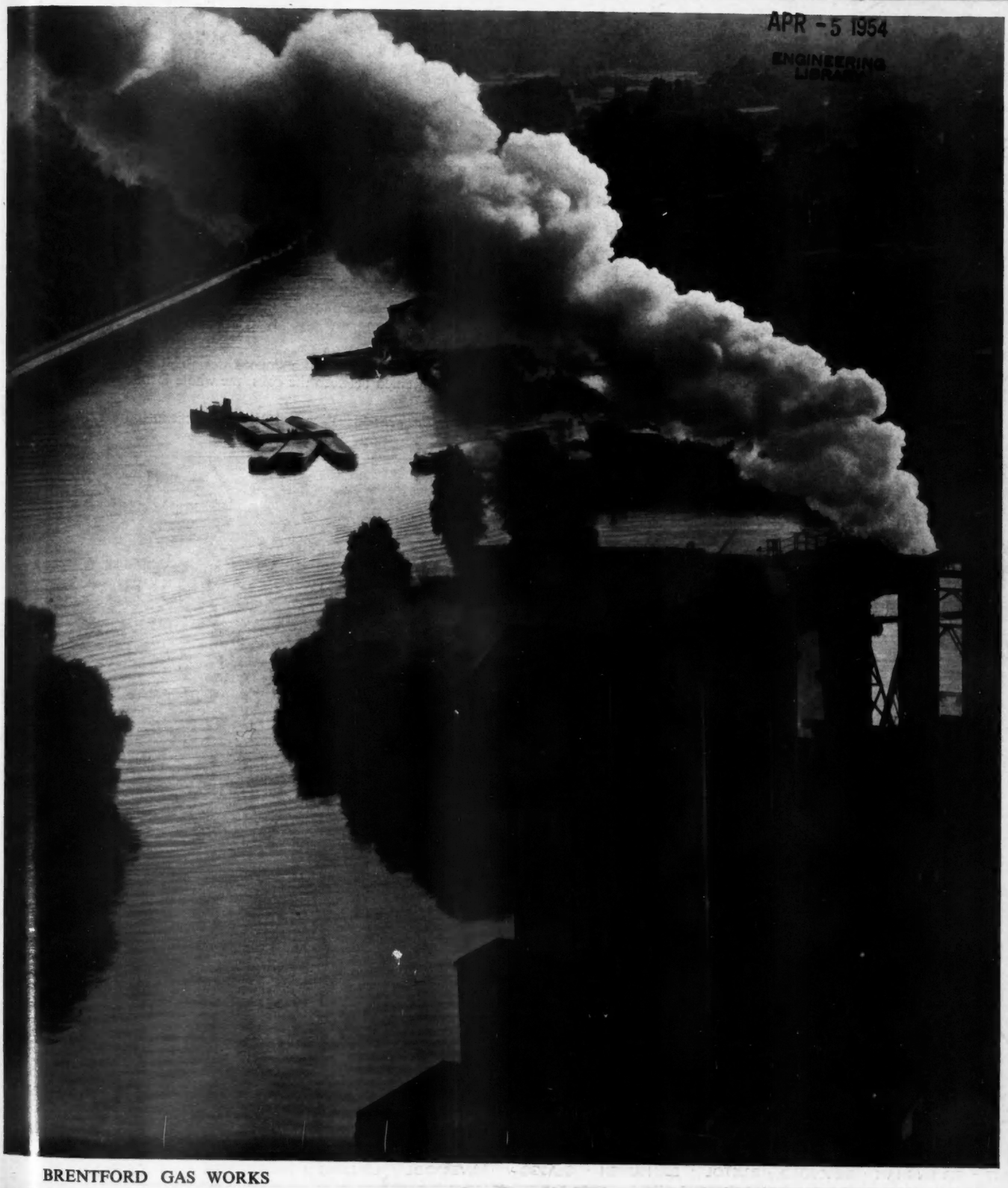

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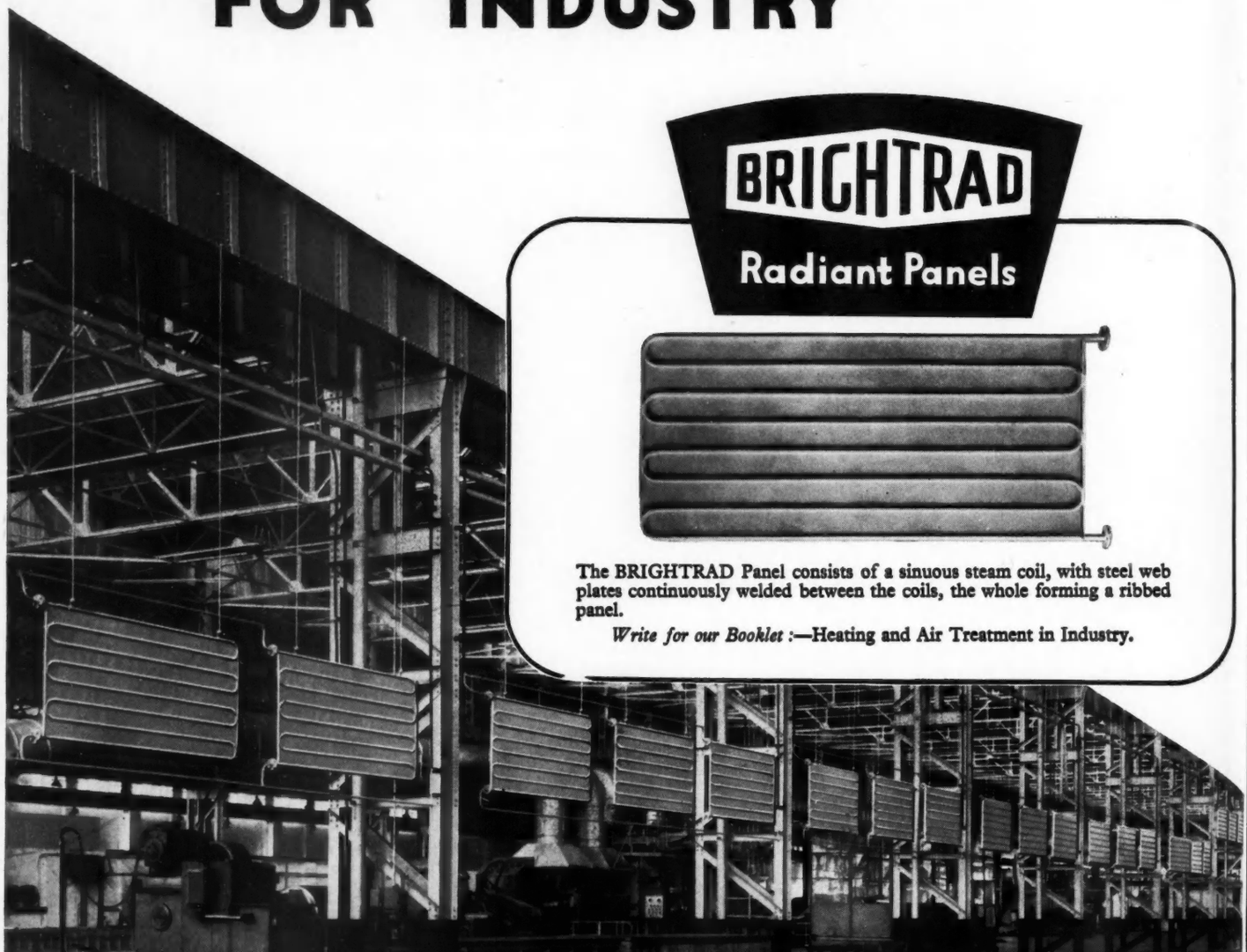

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AN AMERICAN'S VIEW

COMPARISONS unfavourable to this country are frequently made between the relative percentages of the population receiving a university education in Great Britain and the United States. On bare figures, the disproportion certainly exists, but to an important extent it may be explained by the fact that like is not being compared with like. This is clearly shown in an article, "A Look at British Technical Training," which appeared in the February issue of *Mechanical Engineering*, published by the American Society of Mechanical Engineers. The article was contributed by Mr. W. S. Rouverol, Assistant Professor of Engineering Design in the University of California. The point that like is not being compared with like may be made at once by quoting Mr. Rouverol to the effect that "the Higher National Certificate in Engineering is more or less equivalent to . . . an average American bachelor's degree." The illegitimacy of the usual comparison is further accentuated by Mr. Rouverol's implication that as many as half of the undergraduates in America do not complete the course.

British students entering a university have had a training "in languages, history and mathematics that in America is not scheduled until at least the freshman year of college, and in some cases even later." Specifically, "British students entering a university . . . although about the same age as American high-school graduates, already have completed a thorough course in integral calculus, normally considered in the United States a second-year university subject." In general, "the British university entrant is academically at least a year ahead of his American counterpart."

Even if Mr. Rouverol is inclined to overestimate the attainments of the average British university entrant, it would appear that the first-year college course in America is devoted to instruction which in this country is given at school. As a result, the standard material of basic engineering courses is covered in Great Britain in about half the time devoted to it in America. The ratio of students to staff may also be a significant factor. The British average is seven to eight students per staff member, the American is 16 to 1; in some cases it is as high as 30 to 1.

It should be said at once that the academic status of the leading American universities, and the levels reached in some of the graduate engineering schools, are comparable with those of any country, but the majority of American universities contain examples of many degrees of excellence. In broad terms, the engineering undergraduate, undergoing a course of training of the same length as that usual in this country, owing to the fact that he spends his first year on what may be called school instruction, is less able to concern himself with "mastering fundamentals," and instead spends his time in "the learning of techniques for treating particular types of problems."

In view of the remarkable productivity of the United States and the achievement in every branch of engineering, it might appear that a system under which universities "give a broad cultural and vocational background to as many students as possible" is more valuable than one which trains "scholars and professionals." As against this suggestion it may be pointed out that in this country the broad cultural background is expected to be given at school and that the vocational background is provided in the numerous technical colleges. It would appear that British public and grammar schools, plus technical colleges, may be equated to the undergraduate section of American universities.

In case this judgment should appear harsh or unfair, it may be pointed out that Mr. Rouverol is himself not entirely satisfied that the American procedure is the best that can be devised. He refers to the fact that university graduates in Great Britain are selected by examination and on a basis of ability, but that "segregations based on intellectual aptitude are essentially antithetical to American academic traditions." The "equally strong tradition" of training "as many students as possible at all levels creates the basic problem." This basic problem is that to train masses of academically ill-prepared students to a higher level than is now attained "would require much lower student-faculty ratios."

Mr. Rouverol does not suggest that the American educational world could not afford such more generous staffing, and it may be assumed that he would welcome it since, after referring to various questions which such a departure would raise, he concludes his article with the words "these are some of the questions which would seem to deserve serious consideration before we can afford an unqualified acceptance of our present system of undergraduate technical training." The two most important questions would appear to be: how much acceleration in the instruction of the more capable students can enlarged staffs achieve? And how much creative energy and imagination are wasted through unduly protracted training?

Weekly Survey

TRANSISTORS

The last year or so has seen the transistor grow from a rare item in an experimental laboratory to a commercial product of wide application. It fulfils many of the functions of a radio-valve, and also has some specialities of its own, but the main appeal is because it is so much smaller than a valve, consumes only a minute fraction of the power and has not the fragility of a glass envelope. Concurrent with the development of the transistor has been the production of miniature radio parts to go with it; there are transformers weighing less than 0·1 oz., mercury batteries the size of a pencil tip and tantalum capacitors the size of a match head. With these parts, and using printed circuits, the possibilities of miniature equipment become enormous; indeed a wrist radio receiver is in production for the United States Army. With a total weight of 2⅛ oz. including batteries, it has a reception range of 40 miles.

Transistors have been on sale in America since the end of 1952, but their commercial manufacture in this country has only recently been announced. As there is no heat to be dissipated, the transistor and its circuits can be completely encased in a plastic block, rendering the entire equipment independent of atmospheric conditions, and quite capable of complete submersion. There are even metal encased transistors which can be frozen or boiled and will continue to operate under either condition. One of the first applications when transistors came on the open market was to hearing aids. Their use has brought about a reduction in size and weight and a greatly increased battery life, although the initial cost is higher than for those using valves.

Until now, the use of transistors has had to be confined to circuits which only required the small power that they could give – not more than 150 milliwatts. But during the last three months news has been received of two American firms making (at present for their own use) transistors with power outputs of 20 watts, or more than 100 times greater than the previous models. The production of these will again extend the range of uses, although they will require some degree of cooling, and the portable transmitter operated by two flash-lamp batteries has become a fact. These new types will also operate at very much higher frequencies than either the point-contact or junction types, which again increases their usefulness. A brief description of the operation of the last two is given on page 347.

* * *

ACCELERATING AIRCRAFT DEVELOPMENT

On Monday, March 1, the Minister of Supply, Mr. Duncan Sandys, said in Parliament that the Government had been examining possible ways of cutting down the time required to develop new types of aircraft. He believed that a quicker start could be made on a new project if the aircraft firms were consulted more fully in the early stages; and that time could be saved by authorising production drawings and tooling earlier than hitherto. He was consulting the aircraft industry on these and other proposals. The major technical advances embodied in new aircraft resulted in necessarily long flight trials; at present these trials were taking up to three years. It had generally been the practice to order two prototype aircraft only, and if one crashed or required modification, lengthy delays could follow. In future, therefore, the Government would order a greater number of aircraft for development. In the case of the first supersonic fighter aircraft now under development, twenty pre-production aircraft had been ordered.

The aircraft industry has welcomed the change because, in allowing flight trials to be carried out on several aircraft at a time, it will be possible to start test-flying the various operational equipment at an earlier stage. A certain amount of jigging and tooling will be needed for the pre-production line, which will be available for use when quantity production begins. It should also be possible for Service pilots and aircrews to evaluate the new aircraft at an early stage, which should help to reduce teething troubles.

On March 4, when introducing the air estimates, Mr. Ward, Under-Secretary of State for Air, said that financial provision had been made for some Vickers-Armstrongs Valiant aircraft to be delivered during the coming year. The Hawker Hunter aircraft was expected to take its place alongside the Swift this year in squadrons of Fighter Command. The development of the Avro Vulcan and the Handley Page Victor bomber aircraft, and the Gloster Javelin all-weather fighter, was going well. A new mark of Venom was to be introduced this year into the night-fighter force, which was to be nearly doubled. It would soon be possible to demonstrate an aircraft capable of supersonic speed in level flight.

* * *

TELEVISION

Two important developments in the provision of television serving in this country were announced last week. The first was a statement by the Postmaster-General on Tuesday, March 2, that the licence fee would be increased from £2 to £3 per annum from Tuesday, June 1. Of the sum thus raised the Exchequer is to retain £2 million during the next three years and a further £750,000 during the second and third years. The latter sum will be given to the competitive television authority. The Post Office will also retain about £1,600,000 per annum to cover the cost of collecting licence fees and removing causes of interference. It has been assumed, perhaps somewhat optimistically, that by March 31, 1957, there will be 5,300,000 licence holders and, on this basis, the British Broadcasting Corporation (who will receive the balance) will obtain about £17 million next year, £18·5 million the year after, and £20 million in the third year. These sums compare with the £13 million received in the current year, which the Corporation has had to supplement by drawing £1½ million from its reserves.

This increase in income will, according to a statement made by Sir Ian Jacob, enable a television chain covering 97 per cent. of the population to be completed within three years. It will also enable more outside broadcast equipment to be brought into service, both in London and in the provinces, and the Television Centre at the White City to be extended. In addition, it is hoped that approval will be given for the construction of very high-frequency stations to be begun. Finally, colour television will be introduced without delay when the existing technical problems have been solved. The state of uncertainty which has hampered the actions of the Corporation therefore seems, at least partially, to have been removed.

On Thursday, March 4, a matter which has been the subject of much controversy reached a further stage by the introduction of the Television Bill. This gives effect to the Government's proposals for a commercial television service operating under a public corporation. Except that it provides for the establishment of transmitting stations in London, Birmingham and Lancashire, the Bill's contents are almost entirely non-technical. It may, however, be mentioned that it will remain in force for ten years, and that it provides for the establishment of a body to be known as the Independent Television Authority.

* * *

SMALL FIRMS

Britain's industrial progress and economic prosperity have been due in large measure to the achievements of small producers and trading units. Last year, a successful conference on the management of small firms was arranged under the auspices of the British Institute of Management, 8 Hill-street, London, W.1, and other bodies. A further conference, on the same general theme, has since been organised by the Institute in conjunction with the Federation of British Industries, the Midland Area of the National Union of Manufacturers, and the Birmingham Branch of the Institute of Industrial Administration. It took place at Ashorne Hill, Warwickshire, on March 5, 6 and 7.

Among the papers considered was one entitled "Can the Small Firm Afford Work Study?" by Mr. G. J. P. Moorhead. In this, the author described the impressive results obtained by a small textile-manufacturing company coping with the seasonal and personal requirements of a variety of customers. After the introduction of an incentive scheme based on work measurement, production was almost doubled in many departments and very considerably increased in the others.

Although the firm's trade was good, the incidence of overtime and night-shift working was high, there were many requests from the different departments for advances in wage rates, and there was no form of piecework or payment-by-results scheme in operation. In these circumstances, it was felt that a stage in the company's development had been reached where a precise method of labour organisation and cost control was needed and, accordingly, a work-study scheme was introduced. During the first five weeks after the commencement of the scheme, the team under observation earned no bonus at all but, when it became apparent to all operatives, including those in other departments, that extra effort was being well rewarded, the employees' full co-operation was obtained. The next department to be studied reached the bonus-earning stage during the first week.

Warnings against trying to sell goods on a trial-and-error basis without first making a thorough study of the market, and against endeavouring to conduct long-range selling from behind an office desk, were given by Mr. J. Davis in a paper entitled "Export Marketing for the Small Firm." He pointed out that, however large a firm's export trade might be, only personal visits to the market could determine to what greater extent that trade could be developed. Mr. Davis said that American buyers, in particular, were always keen to meet those who sold them goods.

In a paper on costing, Mr. H. G. Houghton advocated the greater use of standard methods and put the case for employing scientific processes in management. The author recognised that management could be practised successfully without a great deal of tabulated information being available, but suggested that, if the same measure of success was applied in conjunction with scientific principles, the result would be a

far higher degree of efficiency. It would, moreover, provide that continuity of management which was often absent when the successful individual retired from control.

* * *

Letters to the Editor

BALANCING A ROTATING DISC

SIR, The graphical construction for determining the unbalance of a rotating disc given by I. J. Somervaille in your issue for February 19, on page 241, leads to a very simple calculation. For two trial masses at 180 deg., referring to Fig. 5 of the article,

$$R_1^2 = U^2 + T^2 - 2\,U\,T\cos\theta,$$
$$R_2^2 = U^2 + T^2 + 2\,U\,T\cos\theta.$$

By adding these equations θ is eliminated and an equation for T is obtained in terms of the measured amplitudes. This is

$$T = \sqrt{\{\tfrac{1}{2}(R_1^2 + R_2^2) - U^2\}}.$$

The initial unbalance is then easily calculated in terms of the trial unbalance by

$$m_0 r_0 = m_1 r_1 \frac{U}{T}.$$

The angle is found by substituting in the intial equations. For three trial masses arranged at 120 deg., referring to Fig. 3,

$$R_1^2 = U^2 + T^2 - 2\,U\,T\cos\theta,$$
$$R_2^2 = U^2 + T^2 - 2\,U\,T\cos(120\text{ deg.} - \theta),$$
$$R_3^2 = U^2 + T^2 - 2\,U\,T\cos(240\text{ deg.} - \theta).$$

These three equations may be added, and the terms involving the angles will disappear from the sum, giving

$$T = \sqrt{\{\tfrac{1}{3}(R_1^2 + R_2^2 + R_3^2) - U^2\}}.$$

The initial unbalance can then be found.

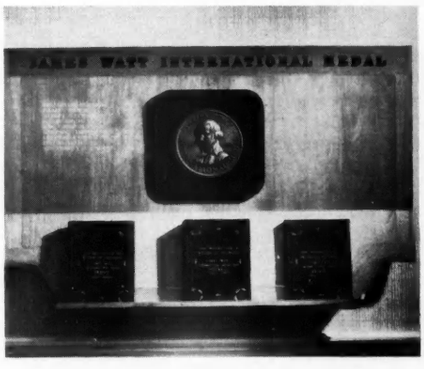
Yours faithfully,
J. JENNINGS, B.Sc., M.I.Mech.E.

The Technical College,
St. Helens,
Lancashire.
March 1, 1954.

NEW ROOMS AT THE I.MECH.E.

The new rooms at the Institution of Mechanical Engineers, which were formally declared open by the President of the Royal Society, Dr. E. D. Adrian, a fortnight ago, are worthy and tasteful embellishments of the headquarters of the largest professional engineers' institution in Great Britain. They will undoubtedly add to the interest with which new members make their first visit to Storey's Gate – or, using the address the Postmaster-General now prefers, to No. 1 Birdcage Walk.

The George Stephenson Room, which is illustrated below, contains a collection of mementoes of the Institution's first President, most of them presented in the Institution's centenary year, 1947, by Colonel S. J. Thompson, past-president. It includes the desk at which Stephenson worked, as well as portraits of him and his son Robert. The James Watt Room is furnished as a committee room and at one end, in a niche, is the bronze bust of Watt which has been presented to the Institution by Mr. G. Nelson Haden, as reported on page 289 of last week's issue of ENGINEERING. Facing this bust, on the opposite end wall, is a panel devoted to the James Watt International Medal (illustrated herewith).



Records of the James Watt International Medal.

The two rooms are approached through the new President's Gallery, which opens off from the main entrance hall of the Institution. The walls of this gallery are hung with portraits of past-presidents, and at the end of it a room has been furnished for the use of the President during his year of office.

In planning the alterations and decorations the Institution had the services of their architect, Mr. Ernest Ruthen, and of Sir Hugh Casson, who advised on the furniture and general decorations.

The new George Stephenson Room at the Institution of Mechanical Engineers. The desk at which Stephenson worked is among the mementoes preserved there.

* * *

AN INTERNAL-COMBUSTION ENGINE CONGRESS

Appeal for Official British Participation

An attempt is being made to secure adequate support for official British representation at the International Internal Combustion Engine Congresses. Letters signed by Mr. H. N. G. Allen, Mr. W. K. G. Allen, Mr. A. K. Bruce and Admiral D. J. Hoare have been sent to a wide range of trade associations and to manufacturers of bearings, blowers, centrifuges, couplings, fuel-injection equipment, heat exchangers, lubricants, pistons and piston rings.

The French sponsors of the Congresses, the Syndicat des Constructeurs de Moteurs à Combustion Interne, held the first in Paris in 1951, with 500 delegates from 16 nations. They established a permanent secretariat and a standing committee on which nine European countries were represented. It is expected that congresses will be held every four or five years. The next will be at The Hague in May, 1955, and it will discuss railway, marine and stationary applications of Diesel engines. An intermediate conference held in Milan in 1953 discussed the use of heavy fuels in Diesel engines. Britain was not officially represented but 30 British delegates attended and three of the 30 papers were by British authors.

The letter of appeal states that " although the aims of the (1951) Congress were technical, it stood out clearly that some European nations were taking full advantage of the Congress to further to the utmost their use of technical reputation for commercial purposes." Individuals from this country can take part, but there is no official British representation. An attempt was made last year to persuade a few trade associations to take part in the organisation of British support but there was " unwillingness to accept a financial obligation which should be more widely borne."

The two objects of the present appeal are (1) to form a committee or to ensure otherwise that British industry takes part in the congresses; and (2) to raise the necessary funds. If most of the organisations to whom the letter was addressed join in, less than £40 a year would be required from each.

The signatories of the letter ask the recipients whether they would support the formation of a national committee, and, if so, with what financial or other limitations; whether they could suggest an alternative way of ensuring British participation; and whether they can suggest any additional organisations to whom the appeal could be addressed.

The matter is clearly urgent since, for the 1955 Congress, synopses of papers were to have been submitted by February 15, 1954, and completed texts of papers are to be delivered by September 30 next. In 1951, due to an absence of advance publicity, it was only after the date on which synopses were due to be submitted that the British Internal Combustion Engine Research Association were invited to contribute.

Inquiries should be sent to the organisers, I.C.E. Congress Appeal, c/o Diesel Engine Users Association, 56 Victoria-street, London, S.W.1

NEW BLAST FURNACE BLOWN-IN AT SCUNTHORPE

The first of two blast furnaces under construction at the South Ironworks, Scunthorpe, Lincolnshire, of the Appleby-Frodingham Steel Co., was blown in on March 1, by Sir Walter Benton Jones, Bt., chairman of the United Steel Companies, Ltd., Sheffield, of which the Appleby-Frodingham Co., is a constituent concern. The furnace has a hearth diameter of 27 ft., and a working volume of 43,000 cub. ft. It is equipped with 18 hearth tuyeres and nine bosh tuyeres; carbon refractories are used exclusively on the hearth and bosh and the stack is lined with firebricks of the standard type. Using a 100 per cent. sinter burden it is hoped that a production of well over 6,000 tons of pig iron a week will be regularly maintained. About two-thirds of the iron will be used in its molten state for steelmaking and the remainder will be cast into pigs and supplied to two associated companies, Steel, Peech & Tozer, Rotherham, and Samuel Fox & Co., Stocksbridge.

LOCAL LEAN ORES USED

In order to reach the large output of 6,000 tons a week with the exceptionally lean local ores used, which have an average iron content of only 24 per cent., the ore has to be carefully prepared before it is charged into the furnace. Even so, the production of 6,500 tons of iron entails the production of 8,500 tons of slag and this has necessitated the introduction of a third slag notch in the furnace structure instead of the usual two. The ore-crushing plant consists of a primary roll crusher and two secondary cone crushers capable of dealing with 800 tons of iron ore per hour. The sinter plant comprises four continuous moving pallet strands, 72-in. wide and 168 ft. long, equipped with 28 wind boxes. The four strands have a combined capacity of 28,000 tons of sinter a week.

BLOWING EQUIPMENT

The blast-furnace blowing equipment consists of four steam-turbine driven centrifugal blowers, each capable of delivering 75,000 cub. ft. of air per minute from a temperature of 0 deg. C., and a pressure of 760 mm. of mercury against 30 lb. per sq. in. gauge pressure. The four water-tube boilers have each a capacity of 85,000 lb. of steam per hour at a pressure of 450 lb. per sq. in. Two of the boilers and one of the turbo blowers are now in commission. The blast-furnace gas-cleaning plant is of modern type and includes dust catchers, cyclone-type separators, washers and electrostatic precipitators.

WATER-COOLING INSTALLATION

Two water-storage tanks, each holding 1,500 tons of water and providing an half-hour emergency supply to the blast furnaces and the gas-cleaning plant, are carried on a reinforced-concrete tower 190 ft. in height. All cooling systems are closed circuits in order to conserve water. The hot water after use is passed through a reinforced-concrete natural-draught cooling tower, 180 ft. in diameter at the base and 285 ft. in height and, after cooling, the water is recirculated. The cooling tower deals with the water from the turbine condensers, the gas-cleaning plant and the cooling system of the blast furnace itself. Water from the gas-cleaning plant, however, is clarified by a flocculation process before it is cooled.

The second new blast furnace under construction at the South Ironworks, has a hearth diameter of 28 ft. 6 in. and a height of 217 ft. When this furnace is completed other less-efficient furnaces will be blown out and the installation at the South Ironworks will consist of four blast furnaces which are expected to produce an aggregate of 1,300,000 tons of iron a year.

The contractors for the blast furnaces are Ashmore, Benson, Pease & Co., Ltd., Stockton-on-Tees. The blowing equipment was supplied by the Parolle Electrical Plant Co., Ltd., Newcastle-upon-Tyne, the gas-cleaning and the sinter plants by Head, Wrightson & Co., Ltd., Thornaby-on-Tees, and the primary and secondary iron-ore crushers by Ross Engineers, Ltd., Surbiton, Surrey. The chief designer in charge of the extensions at the Appleby-Frodingham Works is Mr. I. M. Kemp.

EUROPEAN COAL AND STEEL COMMUNITY

It is now common knowledge that the main results of the establishment of the European Coal and Steel Community have been the creation, as from February 10, 1953, of a common market for coal, iron ore and scrap and, from May 1, 1953, for steel, across the frontiers of Belgium, France, the German Federal Republic, Luxembourg, Italy and the Netherlands. This step has eliminated many trade barriers, including customs duties, quantitative restrictions on imports and exports, double pricing, transport discriminations, and restrictions on the allocation of currency for trans-frontier commerce.

INCREASED TRANS-FRONTIER TRADE

A "Report on the Situation at the Beginning of 1954," drawn up by the international executive council of the Community, or High Authority as it is called, has recently been issued. One point emphasised in the report is that the common market has led to increased trade. Thus, from January to November, 1953, the coal exchanges between the countries of the Community rose by three million tons or 20·4 per cent., compared with the corresponding period of 1952. As a result, imports of coal from the United States, a costly dollar item, have fallen by 61 per cent., from 15·5 million tons to six million tons.

Deliveries of iron ore rose from 950,000 tons a month in January and February, to nearly 1,100,000 tons a month from March to July. During the first ten months of 1953, trade in scrap increased by 66 per cent. as compared with the corresponding period of 1952, namely from 360,000 tons to 600,000 tons. Italy, the principal consumer of imported scrap, has been the main beneficiary from this improved supply position.

Notwithstanding adverse conditions on the steel market, trans-frontier trade was maintained at a level corresponding to the average for 1952, i.e., 237,000 tons a month. In October there was even an increase of 20 per cent., to 287,000 tons. Thus, in the face of a declining demand, the existence of the common market has rendered easier the task of adapting production and prices. Some steelworks have extended their sales outside their traditional national market, whereas, in the absence of a common market, these firms would have retrenched and limited their production, while trying to maintain their prices. On the common market, on the other hand, producers were able to sell in regions where the demand was relatively stronger and the consumers benefited by a fall in real prices.

PROJECTED DEVELOPMENTS

On the question of future projects, the Community aim to modernise methods of coal production and in particular those relating to coking coals. The output of all coals in 1953, totalled 239 million tons and it is planned to increase the production of coking coal by 20 to 22 million tons a year and to increase the productive capacity of coking plants by some 9 or 10 million tons per annum. Another aim is to modernise iron-ore mines by augmenting the annual productive capacity from 62 to 80 million tons and by improving methods of ore treatment.

The countries of the Community produced, from plant having an estimated annual productive capacity of about 44 million tons, 41·8 million tons of steel in 1952 and about 40 million tons in 1953. The demand, however, is expected to increase and a production target of 50 million tons of steel has been set for 1957–58. The necessary augmented capacity, it is emphasised, will be obtained by modernising existing plants rather than by building new installations.

* * *

IRON AND STEEL INSTITUTE MEETING IN SWEDEN

The detailed programme of the special meeting of the Iron and Steel Institute to be held in Sweden from Monday, June 7, to Friday, June 18, has been issued.

The period from the evening of June 9 until Sunday, June 13, will be spent in Stockholm. On Friday morning, June 11, a technical session will be held at Riksdagshuset, Stockholm, when three papers, namely, "Current Problems in Iron Ore Beneficiation," by Mr. G. Kihlstedt; "Calculation of Roll Pressure and Power Consumption in Hot Rolling," by Mr. G. Wallquist; and "Testing of Deep-Drawing Properties of Sheet Steel," by Mr. O. Svahn, will be read and discussed. The proceedings will be in Swedish, but contributions to the discussion, in English, will be welcomed.

A second technical session – a joint one of the Iron and Steel Institute and Jernkontoret – will be held at Riksdagshuset on the morning of Saturday, June 12. The proceedings will be in English and six papers will be presented for discussion in two groups. The first group comprises "Some Aspects of Pelletising Iron-Ore Concentrates," by Mr. M. K. Tigerschiöld; "Experiments on the Pelletising of Fine Iron Ores," by Mr. J. M. Ridgion; and "The Pelletising of Northampton Sand Ironstones by Vacuum Extrusion," by Mr. A. Stirling. The second group comprises "Tensile and Impact Properties of Fe-Si, Fe-Ni, Fe-Cr, and Fe-Mo Alloys of High Purity," by Mr. W. P. Rees, Mr. B. E. Hopkins and Mr. H. R. Tipler; "Effect of Heat Treatment on the Brittleness of High-Purity Iron-Nitrogen Alloys," by Mr. B. E. Hopkins and Mr. H. R. Tipler; and "Pearlite-Free Basic-Bessemer Steel: Its Fabrication and Properties," by Mr. A. Joseffson. A seventh paper, "The Universal Decimal Classification Applied to Metallurgical Literature," by Mr. E. Öhman and Mr. J. P. Saville, will be presented but not discussed.

FUEL AND POWER IN THE CHEMICAL INDUSTRY

A Symposium

A one-day symposium on fuel and power in the chemical industry is being arranged by the graduates' and students' section of the Institution of Chemical Engineers, and will take place on Friday, April 23, 1954, at the Battersea Polytechnic, Battersea Park-road, London, S.W.11.

The morning session, from 10 a.m. to 1 p.m., will be held under the chairmanship of Professor T. R. C. Fox, Shell Professor of Chemical Engineering, University of Cambridge, and will be opened with a paper entitled " World Energy Resources: Present and Future," by Dr. A. Parker, of the Department of Scientific and Industrial Research. Other subjects to be considered will include steam generation for chemical plant, chemical engineering aspects of gas manufacture, and the production of heavy fuel oils.

At the afternoon session, from 2.15 to 5.30 p.m., the chairman will be Sir Harold Roxbee Cox, Ph.D., M.I.Mech.E., chief scientist to the Ministry of Fuel and Power. Subjects to be considered at this session will include the use of electricity in the electro-chemical industry, the use of steam in evaporation, the use of gas in the chemical industry, and the burning of heavy fuel oils. A paper will be contributed on each of the subjects mentioned and this will be followed by a brief discussion. There will also be a paper on " Trends in Fuel Economy," by Professor R. J. Sarjant, O.B.E., D.Sc., Professor of Fuel Technology, University of Sheffield. The achievements of the symposium will be summarised by Professor F. H. Garner, O.B.E., M.I.Mech.E., director of the Department of Chemical Engineering, University of Birmingham.

Programmes and further information may be obtained from the secretary of the Institution, 56 Victoria-street, London, S.W.1.

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CAMBRIDGE UNIVERSITY SCHOLARSHIP

United Steel Companies' Gift

A university entrance scholarship, tenable at St. John's College, Cambridge, has been endowed by United Steel Companies, Limited, Westbourne-road, Sheffield 10, and will be open for competition among those who desire to study physical or mechanical sciences at the College.

The scholarship, valued at £100 a year, will be offered annually at the open examination for entrance scholarships and exhibitions at the College.

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GAS ABSORPTION SYMPOSIUM

Arrangements have been made by the Institution of Chemical Engineers to hold a symposium on " Gas Absorption " at the University of Birmingham, Edgbaston, Birmingham, 15, from Monday, April 5, to Wednesday, April 7, 1954. The wide range of subjects to be discussed will include equilibrium and rate data for amine solutions, carbon dioxide absorption in alkaline solutions, cooling and dehumidification of air in a packed column, matter transfer in the gas phase, kinetics of liquid film processes in gas absorption, design of technical apparatus for gas absorption, absorption of carbon dioxide in ammonia solutions in agitated vessels, the absorptive mechanism in centrifugal gas absorbers, absorption of carbon dioxide by water and Ethanolamine, the Pall Ring, and pressure-drop characteristics of a grid tray.

Most of the papers read will be preprinted. Further particulars may be obtained from the secretary, Institution of Chemical Engineers, 56 Victoria-street, London, S.W.1.

PERSONAL

THE EARL OF SCARBROUGH, K.G., P.C., G.C.V.O., G.C.S.I., G.C.I.E., T.D., has consented to become Patron of the Midland Institute of Mining Engineers, which has been federated with the Institution of Mining Engineers since 1890.

The Department of Scientific and Industrial Research announce that SIR FRANK SMITH, G.C.B., G.B.E., D.Sc., LL.D., F.R.S., retires from the chairmanship of the Road Research Board on March 31; the new chairman will be MR. E. J. POWELL, County Surveyor of Glamorgan, who will hold office for five years. MR. W. K. WALLACE, C.B.E., M.I.C.E., M.I.Struct.E., retires from the chairmanship of the Building Research Board on March 31; his successor is SIR HERBERT MANZONI, C.B.E., M.I.C.E., City Engineer of Birmingham, who will occupy the post for five years. SIR WALTER DRUMMOND, M.I.C.E., M.I.Mech.E., deputy chairman of the National Coal Board, has been appointed chairman of the Geological Survey Board in succession to SIR ARTHUR TRUMAN, K.B.E., D.Sc., F.G.S., M.I.Min.E., F.R.S., who retired from the post, owing to ill-health, in January.

MR. H. H. MULLENS, B.Sc., M.I.E.E., chairman of the North-Eastern Electricity Board, Newcastle-upon-Tyne, has been appointed managing director of A. Reyrolle & Co., Ltd., Hebburn-on-Tyne, as from May 31.

MR. F. N. WOODS, has relinquished the duties of superintendent, lamp and lighting department, Metropolitan-Vickers Electrical Co., Ltd., London. His successor is MR. S. G. TURNER, and MR. J. J. BERRY has succeeded Mr. Turner as superintendent, lamp and lighting department, Cardiff.

MR. B. H. DULANTY, chairman of Silentbloc Ltd., Victoria Gardens, London, W.11, and MR. I. M. GILLETT, the managing director, have been appointed directors of the Andre Rubber Co., Ltd. MR. H. CLEMENTS, has been appointed joint managing director of the Andre Rubber Co., and a director of Silentbloc Ltd.

MR. S. T. CLAYTON, M.I.Loco.E., has been appointed motive power superintendent, London Midland Region, British Railways, Euston.

CAPTAIN (E) N. E. DALTON, O.B.E., R.N., has been promoted to the rank of rear-admiral (E) with effect from April 5, and appointed on the staff of the Commander-in-Chief, Portsmouth. Rear-Admiral (E) R. COBB, C.B.E., is to be placed on the Retired List, with effect from April 12.

MR. P. J. DAGLISH, B.Sc., A.M.I.E.E., has been appointed manager of the aircraft equipment division of the English Electric Company, Ltd., at Bradford.

MR. J. INNES, C.B., has relinquished the managing directorship and his directorship of Telcon Telecommunications Ltd., but will continue to act as consultant to the board. MR. C. L. G. FAIRFIELD, M.A., M.I.E.E., A.M.I.Mech.E., barrister-at-law, now general sales manager of the Telegraph Construction and Maintenance Co., Ltd., has been appointed a director of Telcon Telecommunications Ltd. MR. W. SAMPSON, B.A., A.M.I.E.E., has been appointed executive director and will take over Mr. Innes' managerial duties.

MR. E. H. GOSLING, has been appointed home sales manager covering cables, plastics and engineering products, the Telegraph Construction and Maintenance Co., Ltd., Telcon Works, Greenwich, London, S.E.10. MR. E. R. SMITH, A.M.I.E.E., A.M.I.Mech. E., has been appointed manager of the firm's new cable factory at Wadeville, near Johannesburg, South Africa.

MR. C. P. D. FRANKLIN and MR. W. WHITTINGTON have been appointed directors of the main board of British Ropes Ltd., Doncaster.

MR. R. J. FALK, has been appointed to the newly-created post of superintendent of flying to A. V. Roe & Co. Ltd. MR. J. H. ORRELL, chief test pilot since 1947, continues his duties in this capacity.

MR. W. L. BARROWS has been elected chairman of Evered & Co. Ltd., Surrey Works, Smethwick, 40, Staffordshire, in place of the late Mr. J. HOWARD WILSON. MR. J. D. W. FIELD has been elected a director.

DR. A. R. ENTWISLE has been made the first United Steel Companies' Research Fellow in metallurgy, at the University of Sheffield.

MR. P. BENYON has relinquished his position as spring-shop manager, Steel, Peech and Tozer branch of the United Steel Companies Ltd., Sheffield, to become manager of the newly-formed work-study department. MR. E. HOUGHTON has succeeded Mr. Benyon as spring-shop manager.

MR. D. B. MORREN has been appointed assistant to Sir William Welsh, K.C.B., D.S.C., A.F.C., representative in North America of the Society of Motor Manufacturers and Traders, 148 Piccadilly, London, W.1.

MR. C. A. EDWARDS has been appointed sales manager of Bryce Berger Ltd., Staines, Middlesex.

With reference to the appointment of MR. A. A. PAGET, M.I.Prod.E., as works manager of Vandome and Hart Ltd., mentioned on page 261 *ante*, Messrs. W. & T. Avery Ltd., inform us that Mr. Paget was planning engineer of their branch factory at Sherburn-in-Elmet, near Leeds, and was not their chief planning engineer as erroneously implied in our paragraph.

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BUSINESS CHANGES

G.W.B. FURNACES LTD., Dibdale Works, Dudley, Worcestershire, have acquired the sole licence to supply and manufacture, for the British Commonwealth, all control gear developed by the firm of OFFICINE MECCANICHE RIUNITE, Milan, Italy.

A new firm, MANIPLASTICS LTD., has been formed to produce plastic articles and to market machines for making plastic components. The directors are MR. H. E. BARTON (managing director), MR. P. J. GARRINI, MR. J. R. GILLUM, and MR. C. G. COLCLOUGH, and the address: Mortgramit-square, Hare-street, London, S.E.18.

THE MASSEY-HARRIS and FERGUSON organisations in the Eastern Hemisphere have been integrated under the parent company, MASSEY-HARRIS-FERGUSON LTD., of Toronto, Canada. Grouped under the overall supervision of the executive committee of the Eastern Hemisphere Division are four main subsidiary companies, with headquarters in the United Kingdom. These are: MASSEY-HARRIS-FERGUSON (ENGINEERING) LTD.; MASSEY-HARRIS-FERGUSON (SALES) LTD., and MASSEY-HARRIS-FERGUSON (EXPORT) LTD.—all three with headquarters at Coventry, and MASSEY-HARRIS-FERGUSON (MANUFACTURING) LTD., with headquarters in Manchester.

As from March 15, the registered offices and the administrative headquarters of THE DE HAVILLAND ENGINE CO. LTD. will be removed from Stonegrove, Edgware, to Leavesden Airfield, Leavesden, Hertfordshire. (Telephone: Garston 2261.) The engineering division of the company is remaining at Stag-lane, Edgware.

JAGUAR CARS LTD., Coventry, have formed a wholly-owned American subsidiary company named JAGUAR CARS NORTH AMERICAN CORPORATION, 487 Park-avenue, New York, U.S.A.

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Obituary

ENG. REAR-ADMIRAL W. R. PARNALL

We regret to record the death on March 2 of Engineer Rear-Admiral W. R. Parnall, C.B., C.B.E., who was London representative of the Parsons Marine Steam Turbine Company, Limited, and a former Deputy Engineer-in-Chief at the Admiralty.

Walter Rudolf Parnall was born on June 13, 1877, and received his early naval and technical training from 1892 to 1897 at the Royal Naval Engineering College, Devonport. He was passed out first on the list and was awarded the Newman Memorial Prize. A further three years, until 1900, at the Royal Naval College, Greenwich, and he was again passed out first on the list, with a second-class professional certificate. Then, for eleven years, he gained experience in various naval vessels and establishments, returning to Greenwich in 1911 as head of the department of marine engineering.

In 1914 he was appointed chief engineer of H.M.S. Erin, and from 1917 to 1919 he held a similar position in H.M.S. Queen Elizabeth. After the war he went to the South American station as chief engineer of the flagship Southampton, and in 1921 he became an engineer inspector at the Admiralty. In 1923 he was promoted to Assistant Engineer-in-Chief, and from 1927 to his retirement in 1930 he was Deputy Engineer-in-Chief. During the last war he was re-employed in the engineering branch of the Admiralty, and subsequently until his death he represented the Parsons Marine Steam Turbine Company in London.

SAFETY ON THE RAILWAYS

EXTENSION OF TECHNICAL AIDS

THE Chief Inspecting Officer of Railways, Lieut.-Colonel G. R. S. Wilson, C.B.E., gave the third of three Cantor lectures, on Safety in Transport, at the Royal Society of Arts on March 8. The other two lectures are reported on pages 327 and 334 of this issue. Colonel Wilson reviewed the history of railway safety and then dealt with modern technical aids. An abridgement of the latter part of his lecture is given below.

VACUUM AND AIR BRAKES

The driving force of the vacuum brake at the usual 21 in. of vacuum is about 10 lb. per sq. in. only; it can be made to develop the same braking force as the 70 lb. per sq. in. or more of the compressed-air brake, but only at the expense of heavier and clumsier equipment under the coaches. Vacuum equipment, however, is simpler and on the whole cheaper in first cost and maintenance. Both systems are equally reliable and failures of the continuous brake to act have been exceptionally rare. The comparative advantages and disadvantages of the two systems are fairly well balanced, but I cannot help thinking that it is better engineering to do the job with 70 lb. of pressure than 10 lb. of comparatively sluggish "suck." Many others hold this view, and it is possible that if we in this country were starting afresh to-day we should go for the air brake with its more lively response to application and release by the driver. The Westinghouse air brake is the standard for our electric trains.

Every endeavour is also made to locate the signals to give the best possible view of them from the footplate, and the modern colour-light signal is a great improvement on the older semaphores in this respect, especially at night. As it only has to be seen from a train on a particular set of rails, its beam can be narrowly focused to give great brilliance and penetrative power, which is especially valuable in mist or fog. Colour lights also enable the signal aspects to be greatly simplified at junctions and complicated layouts, and the arresting colour-light distant signals showing yellow or green, which have been installed extensively in semaphore areas on high-speed routes, have been much appreciated by the enginemen.

AUTOMATIC TRAIN CONTROL

Safety still depends on the personal vigilance of drivers in all weathers, but it can be reinforced by apparatus to furnish a positive link between the wayside signals and the footplate, which is generally known as automatic train control. It can take many forms and has a near relation in the exceedingly costly track and locomotive equipment used on some American railways to repeat the indication of multi-aspect signals continuously in the cab. Automatic train control, however, is by no means universal even on the highly developed railway systems of America and Western Europe, and in this country at present only a comparatively small proportion of the route mileage is so equipped.

The view is generally held that the type known as warning control, which gives an audible warning in the cab and a cancellable brake application when a distant signal is passed at caution, is best suited to main-line conditions in this country. The great value of warning control lies in its ability to prevent the serious type of accident which may result if speed is not reduced at a caution signal – a notable example was the disaster at Harrow; but the proportion of accidents which it can prevent is comparatively small – about 10 per cent. of all the serious accidents in this country in the last 40 years.

This fact, considered in relation to the cost and effort of installation, has been one of the reasons for the hesitancy of some of the former British railway companies to adopt automatic train control, in spite of strong pressure from Government recommendations. Furthermore, with automatic train control it is a case of all or nothing on long lengths of route, whereas other signalling safeguards can be applied piecemeal in the course of renewals with immediate local advantage to safety and traffic movement.

A notable exception was the outlook of the former Great Western Railway, and the London Midland and Scottish Railway had gone in for warning control on a smaller scale. On nationalisation in 1948, the principle was accepted at long last that drivers on all the main lines of British Railways should be given their share of modern technical aids to safe working, and the British Transport Commission then began to develop apparatus to combine the best features of the Great Western contact system and the London Midland and Scottish magnetic non-contact system to meet conditions in all parts of the country on steam and electrified lines.

The development of this apparatus has now reached an advanced stage and is in large-scale trial in day-to-day service on the East Coast main line between Barnet and Huntingdon. When its reliability has been proved to the very high standard which will justify the Minister's approval on the recommendation of the inspecting officers of railways, the Commission propose to extend warning control progressively to all the more important routes.

STOP CONTROL ON URBAN ELECTRIC RAILWAYS

Another form of train control, namely "stop" control, is essential to safety under the special conditions of the London Transport and other similar railways. On the London Transport lines every signal has a trip lever on the ground which engages with and opens a cock on the train pipe to apply the brake with full force when the signal is at danger. The signals, and the track circuits controlling them, are so spaced that a train overrunning a signal at danger will be stopped by the trip well clear of a train ahead. This combination of effects can only be achieved where all the trains run at practically the same moderate speed, and on the London Transport lines, which are all continuously track-circuited with colour-light signals, the free movement of closely spaced trains in great safety has been brought to a fine art, if not to an exact science. I should also mention the two bare copper wires which run along the walls of the tube tunnels. The act of pinching them together at any point opens the circuit-breakers at the substation and removes the current from the conductor rails, as may be necessary in the event of short-circuit fusing or other emergency; the tunnel lighting is brought on at the same time, and the motorman also has a telephone which he can hook on to the wires and so speak to the substation. In the latest development he can also speak to the control centre.

DERAILMENTS

On the question of derailments, I would say first that the tendency of a flanged railway wheel is to stay on the rails, provided always that the designed weight on the wheel is maintained during running within reasonable limits. The proper distribution of weight in running is a very important function in the design and adjustment of railway vehicle springs, which has little or no counterpart on the road. Furthermore, the side-control springs of the leading bogies of locomotives play a very important part in the distribution of the flange pressures, so that no wheel flange takes an excessive share in guiding an engine round a curve at speed or in keeping it steady on the straight. Though much has been learnt by experiment and sometimes bitter experience, scientific analysis of the interaction of the locomotive and the track at speed is a very complex problem, and knowledge on the subject is not yet complete.

The necessity for a strong, stable and well-aligned track with the minimum of inequalities of cross level goes without saying, but track maintenance has to contend with all the vagaries of climate and sub-soil conditions, and locomotives and rolling stock have to be designed to adapt themselves to a certain amount of inequality. Indeed, the track and locomotive must be considered as component parts of one machine, and the more perfectly designed and maintained is the one, the less perfect can be the other. In industrialised countries, the standard of track and locomotive design and maintenance is such that speeds of 80 or 90 m.p.h. and more can be held in perfect safety, and it is only on the rare occasions when adverse factors combine exceptionally at a critical moment that a derailment occurs on plain track.

BREAKAGES AND FAILURES

I am not, of course, speaking of derailments which may be brought about by mechanical or material failures such as the breakage of an axle or a tyre, or the failure of engine motion work. With the constant necessity to keep weight and bulk down, these parts have to be highly stressed, and their design, and the steel of which they are made, has been constantly improved in order to minimise the risk of failure in service. As in almost all branches of engineering, the main cause of trouble is the growing or creeping flaw which may be started by a tool mark during manufacture or by corrosion.

By good design and workmanship the opportunity for flaws to develop can be reduced, but in the present state of the art, they cannot be prevented absolutely, and safety depends on their detection in good time by rigorous examination of the parts during the course of workshop repairs. Flaws in certain positions, for instance in railway axles at the point of high stress where they are pressed into the wheel, are extremely difficult to detect visually or by magnetic methods, but in the last few years periodical testing by methods using ultrasonic vibrations have met with marked success, and carriage axle failures, which were once quite a source of anxiety, have now been reduced in this country to one or two in the course of a year.

We have fewer rail breakages than the railways of some other countries, and they seldom cause serious derailments, although there was one from this cause at Watford last month which, as you probably know, is under inquiry. Prevention of this kind of trouble is largely a matter of good maintenance of the track to avoid undue flexure of the joints, and timely renewal of worn or corroded rails, coupled with conscientious daily examination by the length ganger. Here again ultrasonic methods of testing with light and portable equipment have met with considerable success in the detection of flawed or cracked rails, particularly at the joints.

Apart from actual breakages, derailments can also be caused by parts coming adrift either on the rolling stock or on the track. Nowhere more than on a railway does safety depend on conscientious workmanship to the last detail and rigorous inspection and examination at frequent intervals, and even a missing or badly fitted split pin can have very serious consequences.

THE FUTURE

What of the future? The inherent capacity of railways to carry heavy loads of passengers and freight at high average speeds seems to assure their continuance as a basic means of transport for many years to come, but in this 130th year in their history of public service it is difficult to foresee any startling innovations in their technical safety equipment. Radar for instance has no application to the prevention of railway collisions, at any rate in its present state of development, despite its proved success at sea and in the air, and radio communication is of very doubtful

value to the safety of train operation though it has been found useful in some types of railway control work. We must, of course, anticipate a continuous advance in general engineering knowledge and practice, of which I am sure that full advantage will be taken by the railways, but apart from that it seems that future progress will lie in the wider and wider extension of proved technical safeguards in the course of renewals and modernisation, and their refinement in detail and adaptation to changing conditions of operation. I will not attempt to forecast the future trend of safety on the railways, but there are few accidents in which the human element can be disregarded, and I think we must bear in mind that changing social and industrial conditions bring their distractions with them, and it may be that the need for technical aids to safe working will become more pressing in future than it has been in the past.

SAFETY ON THE ROAD

IMPORTANCE OF VEHICLE MAINTENANCE

Dr. W. H. Glanville, Director of Road Research in the Department of Scientific and Industrial Research, gave a Cantor lecture to the Royal Society of Arts on February 22, with the title of "Safety on the Road." This was the first of a series of lectures on safety in transport.

Dr. Glanville opened his lecture with a review of the death rates from accidents from 1863 to the present time, and compared them to the greater expectation of life. His figures showed that deaths due to vehicles (other than railways) had increased from 143 per million per year at the beginning of the period to 306 for the years 1939-45, and had then fallen to 208 for the period 1946-51. He next proceeded to consider the relative risk of road users and, taking the driver of a four-wheeled vehicle as standard, said that pedal cyclists were 15 and motor cyclists 40 times as likely to be killed. In comparison, passengers in United Kingdom scheduled airways had only 3·7 times the risk of death.

VEHICULAR FAULTS

Turning to the vehicles themselves, Dr. Glanville drew attention to the bad condition of pedal cycles as revealed by tests at schools: 40 per cent. were found to be faulty. The problem of braking and lighting on motorised bicycles was one receiving immediate attention. Dazzle was another objectionable feature and one likely to cause accidents, and tests showed that 40 per cent. of the meeting beams were dazzling due to deterioration and bad setting; 800 vehicles were checked near Oxford and only one in ten had the lamps set correctly. One car in six of those using "dip and switch" had intensities of less than one-tenth their original values, and one in two were below half.

A similar check had been made on brakes, with good brakes defined as stopping a car travelling at 30 m.p.h. in 45 ft. Half the cars tested needed 70 ft., one in ten 100 ft., and one in a hundred over 200 ft. On motor cycles, the front wheel brakes were only efficient in 10 per cent. of those checked. Rear lights were another source of trouble; a survey during the winter 1950-51 showed that 75 per cent. of motor vehicles and 98 per cent. of pedal cycles had rear-lamp intensities below that required for visibility when seen near the dipped headlights of an oncoming car. 80 per cent. of the cycles and 60 per cent. of the motor vehicles had intensities less than one-tenth of that required.

ANNUAL INSPECTION

All these points, said Dr. Glanville, made it clear that the condition of many vehicles was far from satisfactory and he introduced the question of vehicle inspection. This was already being done in America at an estimated cost of 10*s.* per vehicle per annum. He estimated that, if the testing could be done in this country by approved garages, the total cost would be £2½ million per annum; if by this the accidents could be reduced by 20 per cent., the saving to the country as a whole would be about £20 million. In any event, 10*s.* per annum was not a high price for increased safety.

Lastly, there was the human element, into which entered so many unknowns. Individual capability, fatigue, accident proneness, drunkenness, all came into the picture. Driver training was now part of the curriculum in American high schools, and comparison of figures showed that the accident rate of trained to untrained drivers was about one to two. Some such scheme might well be introduced here. The cost to America was £3½ million a year for about 300,000 students. In conclusion, Dr. Glanville pointed out the three tasks: first, to see that equipment, both roads and vehicles, was in first-class order; second, that road users were properly fitted and trained for their responsibilities; and third, that sanctions were properly devised and applied to maintain discipline. Personal discipline, and courtesy were needed by all.

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ACCIDENTS AT NIGHT

Connection between Street Lighting and Road Safety

A Press conference was held on February 15 by the British Electrical Development Association at which Mr. W. Robinson, their Lighting Officer, introduced the subject of improving street lighting with a view to reducing accidents at night. As 99 per cent. of all accidents occur between 7 a.m. and midnight, all the figures quoted refer to that period; also, since children do not use the roads at night to any great extent, only figures for adult casualties were used.

The first point to which Mr. Robinson drew attention was the greater severity of night-time accidents; in 1952 out of every 1,000 adult pedestrian casualties by day, 37 were killed and 245 seriously injured, but the figures by night were 65 killed and 330 seriously injured. Also the accident rate at night was higher, for, during the period 1945-52, 2½ times as many adult pedestrians were killed per hour at night as during the day. The position would seem to be getting worse for in 1945, when 3 million vehicles were licensed, 64 pedestrians were killed at night for each 100 killed by day, but in 1952, with 5 million licensed vehicles, over 100 were killed at night for every 100 by day.

The figures for 1953 at present available showed an increase in the casualty figures in spite of all the efforts at road safety. But the significant fact was, that day time fatalities actually decreased and the whole of the increase in the total was due to the 20 per cent. increase in fatalities at night. Monthly figures showed that fatalities followed the hours of darkness closely; the jump that occurred when summer time was changed being very noticeable. Local authorities were mostly trying to bring their lighting up to that laid down by the code of practice, but expenditure was governed by Defence Regulation 56A and the process would take at least 15 years.

MANUAL LIFTING AND HANDLING

Course for Instructors

In view of the success which has attended the one-day courses on manual lifting and handling arranged by the Industrial Welfare Society during the past two years, the Society has decided to hold a residential week-end course on the same subject at Lilleshall Hall Recreation Centre, near Newport, Shropshire, from Friday evening, March 12, to Monday morning, March 15, 1954. This course is being organised in association with the Central Council of Physical Recreation and will be the only resident week-end course on this subject to be arranged during the present year. It is hoped that the course will prove of particular value to those who desire to qualify as instructors.

Applications to attend should be addressed to the administration officer, Industrial Welfare Society, 48 Bryanston-square, London, W.1. The fee, including residence, is six guineas for delegates from member-firms of the Society, and seven guineas to others.

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ELECTRODEPOSITION AND METAL FINISHING

Conference and Exhibition

The fourth international conference on "Electrodeposition and Metal Finishing, Including Organic Finishing," will be held, under the auspices of the International Council for Electrodeposition and the Institute of Metal Finishing, at the Holborn Restaurant, London, W.C.1, from Tuesday, April 20, to Saturday, April 24, 1954.

Arrangements have been made for the submission of some 24 papers on such subjects as the mechanism of the growth of electrodeposits, techniques available for plating research, the use of tracer techniques in electrodeposition, the polarity of coatings towards the base metal, organic finishing, chromising, tinning, and methods of cleaning. There will be sessions on nickel plating, at which a number of papers by American authors will be read, on alloy plating, and on anodic processes including electropolishing.

An exhibition will be held to illustrate recent developments in electrodeposition and metal finishing techniques and equipment. Opportunities will be provided to visit the metal-finishing departments of a number of important organisations. Programmes and application forms may be obtained from the conference secretary, Fourth International Conference, 32 Great Ormond-street, London, W.C.1.

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CORROSION AND ITS PREVENTION

Battersea Polytechnic Summer School

A four-day summer school is being arranged by the Battersea Polytechnic, in conjunction with the Corrosion Group of the Society of Chemical Industry, on "The Fundamentals of Corrosion and Its Prevention." During the school, a series of eight lectures on the electro-chemical principles of corrosion, immersed corrosion, dry corrosion, atmospheric corrosion, underground corrosion, inhibitors, metal coatings, and non-metallic coatings, will be delivered by Mr. S. C. Britton, Dr. T. P. Hoar and Dr. L. L. Shreir.

The school will be held at the Polytechnic from Tuesday, July 20, to Friday, July 23, inclusive. One or two evenings, from 7.30 to 8.30 p.m., will be devoted to films dealing with various aspects of the subject, and laboratory demonstrations will take place at another evening session. Accommodation will be available at hostels at an inclusive charge of five guineas. The fee for the course will be two guineas. Applications should be made to the secretary, Battersea Polytechnic, London, S.W.11.

PROTECTION OF ELECTRIC RAILWAY EQUIPMENT

PRACTICE ON OVERSEAS SYSTEMS

A report on the protection of overhead lines, substations, locomotives and motor coaches against accidents of an electrical nature (excess voltage, overloads, short-circuits and lightning) has been prepared by Mr. J. F. M. De Boeck of the Chemins de Fer Vicinaux, Brussels. It will be submitted to the International Railway Congress Association at their 16th session, which is to be held in London from Wednesday, May 19, to Wednesday, May 26 next. It is based on a questionnaire which was compiled in agreement with Mr. T. S. Pick of the London Transport Executive and was sent to 70 bodies, only 14 of whom, however, replied. The ground covered is very wide and discloses a great variety in the methods employed to obtain the same objects – safety and continuity of supply.

TRANSFORMER PROTECTION

Excess-current relays acting on circuit-breakers are general for the protection of static transformers. They are either of the delayed-action or instantaneous type, although some thermal relays are used on the French National and Belgian National Light Railways. Protection against overheating is also generally provided, the most common form being thermometers with tripping contacts, one of which sounds an alarm, while the second switches out the transformer. Another system utilises a "thermal feeler," consisting of a resistance located at the warmest part of the oil. This resistance, and consequently the oil temperature, is measured continuously. In a variation of this arrangement the resistance is supplied with current proportional to that which is being controlled and surrounds a bi-metal component, which acts on the control device. It is noted that these equipments are relatively expensive.

Excess voltages in the transformer primaries are guarded against on the German Federal Railways by an earth wire, which is run parallel to the overhead feeders and by increased insulation on the first turns. The latter practice is also followed on the Italian State Railways. Voltage limiters, consisting of a resistance of semi-conducting material connected in series with a number of spark gaps (which are shunted by resistances of the same material) and a "pre-ionisation" element, are used on the Lower Congo-Katanga Railway. A number of undertakings do not employ excess voltage limiters. Mr. De Boeck remarks that none of these devices offers really efficient protection, so that there is no advantage in installing them. The well-known Buchholz relay is, it is noted, fitted to all transformers.

RECTIFIER OVERLOADING

A lengthy section of the report deals with the methods adopted for protecting rectifiers against external and internal overloads and short-circuits. The Belgian National Light Railways is the only one of the 14 railways which uses glass-bulb rectifiers. Even these are being replaced by metal pumpless units, owing to the difficulty of obtaining bulbs during the war and the need to increase the available power. On the heavy traffic sections, where considerable loads and frequent peaks occur at short intervals, these rectifiers are protected by quick-acting maximum-current anode relays and ultra-rapid reverse-current cathode circuit-breakers. For reasons of economy, quick-acting maximum-current anode relays with a cathode contactor have also been used.

An examination of the replies, which are summarised in tables, leads to two conclusions; the necessity for ultra-high-speed reverse-current cathode circuit-breakers for rectifiers with outputs of 1,000 kW or more, whether they incorporate polarised grids or not; and the widespread use of polarised grid control to "block" the anodes. The grids are negatively biassed in several ways. It is, however, impossible to pass judgment on these, as each manufacturer advocates his own method and the user seldom has the opportunity of making comparisons. It is possible that, as stated by the Italian State Railways, grid control is not 100 per cent. effective. The British manufacturers who have been consulted have also been reticent on this subject. The provision of grids considerably increases the cost.

CONTROL GRIDS ABANDONED

At certain substations on the Paris-Lyons line control grids are used for limiting the loads, but this practice has been abandoned in recent electrifications. Similar arrangements are employed in the automatic substations on the Belgian National Light Railways for bringing sets into action as the load increases. Three 630-kW units are connected in this way, any one of which can be selected while the other two act as stand-bys. If one unit becomes defective the next in the series takes its place.

The glass bulbs on the Belgian National Light Railways are virtually unprotected against excessive heating, but the metal units are fitted with thermostats or thermometers to give an alarm, to regulate the cooling or to shut down the set. Such precautions are specially justifiable in hot climates. The information given about the treatment of defects in the cooling system is often irrelevant, but the most usual arrangement seems to be an auxiliary contact which opens the high-tension circuit-breaker. A damper is also used for the same purpose and seems to be a more reliable method.

Failure of the ignition or excitation seems usually to be dealt with by a time-lag relay which disconnects the unit. Rectifiers with pumps on the North of Milan railways are taken temporarily out of service if the vacuum fails and on the Algerian and French National Railways the group can be restored to service at the appropriate time. This arrangement has not given satisfaction on the Belgian National Light Railways. The use of voltage limiters is general and earthing relays are employed by the Régie Autonome des Transport Parisiens and the French National Railways. On the latter system the relays are connected between the negative 'bus-bar and the metal framework of the cubicles. On the same system a thermostat cuts out the rectifier if the temperature of the tanks falls below 25 deg. C. and restores it when that figure is exceeded. On the Belgian National Light Railways the glass bulbs can be heated electrically in winter, control being by time switches. The use of grids as voltage regulators is being given up on the French National Railways, but they have been found satisfactory on the German Federal Railways.

CONTACT LINES AND FEEDERS

As regards the protection of contact lines and feeders the German Federal Railways connect the positive conductor of their direct-current system to the running rail. Several administrations earth the running rails, although the methods used are not stated. Bare overhead feeders are almost exclusively employed for economic reasons, but in the most recent installations, cables are used to connect the substations to the contact wires. The Belgian National Railways lay their cables in concrete troughs at ground level, as this is cheaper than burying them.

High speed circuit-breakers with automatic re-closure are usual on a number of systems. In some cases a limited number of re-closures are permitted in a given time, after which the circuit-breaker remains open. In other cases, re-closing is preceded by an automatic test of the resistance of the line to ascertain whether it is normal. According to the French National Railways, however, this arrangement has more drawbacks than advantages, although the Belgian National Railways find it economically justifiable. This, it is thought, may be due to the low voltage employed on the latter system.

To ensure protection agianst excess voltage, lighting arresters, based on the properties of semi-conducting materials, predominate.

PROS AND CONS OF REGENERATIVE BRAKING

Regenerative braking is used on a 56-mile section of line of the German Federal Railways, the motive power consisting of 43, 1,200-kV direct-current Bo-Bo locomotives. On the 162-mile Rhaetian Railway it is employed on ten 11-kV 16⅔ cycle Bo-Bo locomotives and on the Algerian Railway on 3-kV direct-current locomotives running over 192 miles of line. It is also used on certain sections of the French National Railways, which were electrified before 1942 and in which rotary substations are in operation. It has, however, been discontinued on recently electrified lines and those in course of conversion, as the substations are equipped with static converters. It has also been abandoned on Régie Autonome des Transports Parisiens. Other systems utilising regeneration are the Moroccan and Italian State Railways, but others again do not employ it or expect to adopt it. In fact, the Lower Congo-Katanga Railway on which a 25-kV 50-cycle system is used, has decided that regenerative braking has no advantages to offer them, even though there is a gradient of 1·25 per cent. extending 19 miles.

In this connection the French National Railways point out that regenerative braking is only an advantage when the gradients are steep and form a large proportion of the total length of the line. It then provides an efficient method of retardation without causing excessive wear of the brake shoes. It also saves some electrical energy. On the other hand, it necessitates the installation of fairly costly equipment on the locomotive, the operation of which calls for some skill.

* * *

DEATH-WATCH BEETLE

Dangers of Treatment by Radiation

The possible use of radiation treatment to attack the death-watch beetle in H.M.S. Victory, Nelson's flagship, has been rejected for three reasons. They are: the magnitude of the dose required; the difficulties of application; and the danger to human beings, for whom lethal dosages are of the order of one-hundredth of those required for insects.

Hitherto, damaged parts of the ship have been treated by insecticide without great success. As an alternative method of treatment, the ship is now to be sealed and fumigated, using methyl bromide, in a further attempt to save the timbers.

Book Reviews

Standardisation in the U.S.A. and in Europe. *The Organisation for European Economic Co-operation, 2 Rue André-Pascal, Paris.*

This publication contains a report of a Mission which visited the United States, under the auspices of the Organisation for European Economic Co-operation and the Mutual Security Agency, to study the organisation of standardisation. This is a field of human endeavour which has not altogether been unexplored, since three other national missions have also crossed the Atlantic with much the same object in view. It is pointed out, however, that the body, with whose activities this report is concerned, was of a nature very different from its predecessors. It was made up of 43 experts from 10 different European countries, among whom were specialists on standardisation in certain industries. Operationally it was divided into groups, the first of which studied the general development of standardisation, while the others concerned themselves with the position in particular fields of which machine tools, screw threads and ball and roller bearings were of engineering interest. The results are not without value, especially as indicating certain things which might well be avoided.

In the first place, in the United States the preparation of standards for Government use, whether military or civilian, and of those produced by industry for its own use, are separate activities. The position is therefore, naturally apt to appear confused. It is hardly clarified by the discovery that there are some 50 standardising agencies in the country, a state of affairs which can hardly lead to that simplification which is so desirable. This view is reinforced by a study of an appendix on standardisation in European countries, from which it appears that it is possible to achieve results with much less numerous organisations and even with one. In fact, it is not too much to say that our own British Standards Institution is a model in this respect, although standardisation in Austria, Belgium, Denmark, Germany, the Netherlands, Norway and Sweden and, to a less extent, in France and Italy, is similarly "unitised." It would seem, therefore that as far as standardisation is concerned the Organisation for European Economic Co-operation might indulge in a little introspection.

This opinion is confirmed by the reports made by the specialists on the subjects we have mentioned above. These are factual and to that extent are of interest, but it is evident that progress both in organisation and accomplishment is not so far advanced as might perhaps have been expected. The Mission, however, believes that it is being more and more recognised that it is of great economic importance for the United States to take a full part in international standardisation. If that is the trend of thought a study of this report should be of some assistance in accelerating it.

50-100 Binomial Tables. By HARRY G. ROMIG. *Wiley Publications in Statistics. Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (32*s.*)

This volume presents tables for $(q + p)^n$ where $q = 1 - p$ for positive integral values of n from 50 to 100 in steps of 5 with p values ranging from 0·01 to 0·50 in steps of 0·01. The term in $q^{n-x}p^x$ in the above expansion expresses the probability that, in n trials, an event of simple probability p will occur x times while the mutually exclusive event of simple probability q will occur $n - x$ times. Furthermore, the sum of the first x terms will represent the probability that the former event will occur x times or less in n trials.

Each table, for a particular set of n and p values, is arranged in three columns the first designating the x value, the second, headed "individual term," denoting the probability of exactly x, and the third, headed "cumulative (x or less)," denoting the probability of x or less. The cumulative values are summed from 0 to x. To obtain a probability value for x or more the value for $x - 1$ is read from the third column and subtracted from 1. These tables were computed at Bell Telephone Laboratories in 1947 on a General Purpose Digital computer; the values are given to six decimal places, the last doubtful, so that only values of x between 0 and n are included where a six-place number exists for the corresponding individual term. The range $n = 2(1)49$ is covered in the Tables of the Binomial Probability Distribution (National Bureau of Standards Applied Mathematics Series 6). Probability values for intermediate p values for both tables and for intermediate n values for the present tables require the use of exact or approximate interpolation relations which are discussed in the introduction. Examples are given to illustrate the use of the tables for values of p within the range 0·51 (0·01) 0·99 as well as for values of p within the listed range 0·01 (0·01) 0·50. A further section deals with related distributions covered by these tables over a limited range.

Quality control of manufactured products, to be effective, must be based on an evaluation of the probabilities associated with the various sampling procedures used. In making such evaluations in the past it has been necessary to use approximate values of the p binomial. These can now be replaced by the exact values contained in the present tables for which other uses are likely to be found outside the field of quality control.

The Synchronous Induction Motor. By J. GRIFFIN. *Macdonald and Company (Publishers), Limited, 16 Maddox-street, London, W.1.* (18*s.* net.)

The synchronous induction motor, which was invented by the Swedish engineer, Danielson, in 1900 for the purpose of power factor improvement has been largely developed by British manufacturers to combine the superior starting performance of the wound-rotor induction motor with the desirable characteristics of the synchronous machine. It now has a large field of application and, as the author points out, it is therefore surprising that there is so little published information on its design and construction. The object of this book is to repair this omission by providing an overall review of present practice and especially of the developments that have taken place during the past 30 years.

With this end in view the author begins with a discussion of the behaviour of the motor on starting, which includes a description of the various apparatus available for this purpose. Synchronising is next dealt with, but is briefly dismissed, after which there is a chapter on elementary theory. It is a little difficult to see the logic of this arrangement, as it would seem to have been better to deal with this subject first and to combine it with the discussions on secondary windings and the calculation of exciting currents which come later in the book. Other chapters are concerned with power factor correction, overload capacity, excitation (including Amplidyne control), dynamic braking, inversion (that is connecting the supply to the rotor), and, finally, construction. The pioneer work of Danielson is described in an appendix.

The treatment throughout is practical rather than theoretical, but the various points are well brought out and the value of the text is enhanced by the illustrations. We agree therefore with Mr. Laurence Carr, who in his foreword points out that the synchronous induction motor should now be regarded as a machine in its own right; and expresses the hope that this book will find a place among those works on particular subjects to which reference can be made with advantage even by those who are not specialists.

Instrument Technology. Volume I. **Measurement of Pressure, Level, Flow and Temperature.** By E. B. JONES. *Butterworths Scientific Publications, 88 Kingsway, London, W.C.2.* (35*s.*)

It is stated in the preface to this book that it is hoped that it "will more than cover the requirements of the Intermediate Examination in Instrument Maintenance of the City and Guilds College, London," and that "it should be found useful by industrial firms who have their own training schemes." Volume II, which is to follow, will deal with analysis, telemetering and control instruments, and the two volumes will cover, the requirements of the City and Guilds final examination.

The hope and expectation expressed by Mr. Jones in these remarks are quite unnecessarily modest. This book will no doubt serve as a students' manual but it also has a wider sphere of usefulness. Instruments with an extensive range of type and purpose are now a common feature, and a necessity, in almost any class of properly-organised industry and a volume dealing with their basic principles, their construction, operation and maintenance will be of interest and value to very many works' engineers and controllers of production who are in no way concerned with passing examinations.

The broad range of the book is indicated by its subtitle, but the thoroughness with which each of its four main sections is treated can only be realised by examination. What can here be little more than a list of the contents of the 100, or more, pages dealing with the measurement of temperature will illustrate this. After introductory remarks on temperature scales, the various type of instrument in use are grouped and described on the basis of their fundamental nature. Expansion thermometers are divided into those depending on the expansion of solids, liquids and gases. Change-of-state thermometers include vapour-pressure thermometers and Segar cones. Electrical methods of measuring temperature are dealt with in detail and the section concludes with radiation pyrometers, optical pyrometers and photo-electric pyrometers.

The other sections are equally complete and thorough. It is not likely that any works' man will be concerned with the whole range of instruments dealt with in this book, but it is quite likely that he will be concerned with some. In explaining the principles of the instruments with which he deals, Mr. Jones necessarily introduces a little mathematics, but these are relatively simple and need embarrass no one who reads the book carefully. There are many clear diagrams and detail drawings of parts, with photographic illustrations of most of the instruments referred to.

Elements of Electricity. By W. H. TIMBIE assisted by A. KUSKO. *John Wiley and Sons, Incorporated, 440 Fourth-avenue, New York 16, U.S.A.* (5·50 dols.) *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (44*s.*)

This is the fourth edition of a book which was published by the first of the authors in 1910. It has since been revised with the assistance of Dr. S. H. Caldwell and now of Dr. A. Kusko, who is assistant professor of electrical engineering at the Massachusetts Institute of Technology. It is not surprising that during the intervening period the subject has undergone considerable change and that it has been constantly necessary to re-write the book so that its contents reflect the growth of the industry.

The first ten chapters, which occupy nearly half of the 600 pages, are devoted to that branch of the subject which usually comes under the heading of direct-current. Inductance, capacitance, alternating currents, electronics and electron tubes are then dealt with and there is a final chapter on electrostatics. Each chapter concludes with a summary of its contents and a number of problems are set, although solutions are not given.

The treatment is, in general, descriptive and no great demand is made on the reader's mathematical knowledge. In fact, the work is intended as an elementary text-book and as such should be found useful by students once the slight obstacle of the American language has been overcome. Naturally, conciseness is the keynote; but this has not prevented up-to-date information being given about germanium crystal valves and transistors, as well as about ceramic capacitors, circuit analysis and electrochemical processes.

TRADE PUBLICATIONS

Fescolised Hydraulic Rams. A booklet entitled "Hydraulic Efficiency" has been published by Fescol Ltd., North-road, London, N.7, and deals with the protection of hydraulic ram surfaces by the "Fescol" process, in which a deposit of nickel or chromium is atomically bonded with the base metal. In an introduction by C. C. Harris, Chief Draughtsman, Hydraulic Engineering Co., Ltd., Chester, is given an account of the history and nature of the process, and its advantages, which include reduced expenditure on packing replacement, the prevention of oil leakage and corrosion and the building up of worn parts. Examples of Fescolised rams are shown in illustrations of hydraulic plant built between 1929 and 1952.

Precision Bench Surface Grinder. In a pamphlet issued by the Duffwillans Equipment Co., 797 Harrow-road, College Park, London, N.W.10, is described the "Lomet" bench, precision, surface grinder, which has an overall height of 27⅝ in., and a distance between grinding wheel and baseplate ranging from 0 to 7⅛ in. This machine, which embodies a graduated collar enabling increments of 0·0008 in. to be read directly, is made in Holland, but demonstrations of it may be seen at the above address.

Compressed-Air Equipment for Switchgear. A. Reyrolle and Co., Ltd., Hebburn, Co. Durham, have issued three leaflets describing the installation, operation and maintenance of compressed-air equipment for pneumatically-operated switchgear. The leaflets cover a completely duplicated system, a simplified arrangement and a unit scheme.

Emergency Lighting. Two leaflets have been received from Nife Batteries, Redditch, giving circuits and layouts for emergency lighting installations. One deals with the case where it is required for the lights to be permanently illuminated and the other when they are only needed on failure of the main supply.

Fractional-Horse-Power Motors. Brook Motors, Ltd., Empress Works, Huddersfield, have sent us particulars of a new range of single and three-phase fractional horse-power motors which they are now manufacturing. They are protected and totally-enclosed types for three different outputs and speeds.

Ironclad Switchboards. The General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2, have published a booklet describing in detail their standard components for building up ironclad switchboards. Switch fuses listed range from 20 amp. to 100 amp. and fuse switches from 100 amp. to 500 amp. for circuits up to 500 volts A.C. or D.C. Cable boxes, cable sockets and 'bus-bar chambers are described, and there is a scale drawing of a typical switchboard assembly.

Diesel Engines. Burmeister & Wain, Copenhagen, Denmark, have published a catalogue which gives overall dimensions and performance figures of 25 different four-stroke auxiliary Diesel engines for marine application. The smallest engine listed develops 70 b.h.p. at 600 r.p.m. and the largest, when fitted with a turbo-charger, develops 980 b.h.p. at 400 r.p.m.

Sulphuric-Acid Plant. The Power-Gas Corporation Ltd., Parkfield Works, Stockton-on-Tees, have published a folder giving brief particulars of plant designed and erected by them for the production of sulphuric acid from sulphur, pyrites, hydrogen sulphide, sinter gases, gypsum and other sulphur-bearing materials.

Aluminium-Silicon Alloys. A copy of their revised information sheet, No. 16, on aluminium-silicon alloys has reached us from Foundry Services Ltd., Long Acre, Nechells, Birmingham, 7. It describes very fully the composition, mechanical properties, heat-treatment, melting procedure, modification, and casting and moulding technique of alloys conforming to specifications B.S. 1490, L.M.6 and 3L33, and often referred to as Alpax or Silumin.

Recommendations to Users and Makers of Steel Castings. Following a customer-founder convention held in April, 1953, by the British Steel Founders' Association, Broomgrove Lodge, Broomgrove-road, Sheffield, 10, a series of recommendations to makers and users of steel castings were drawn up. These arose from suggestions made during the discussions at the convention and were first included in a publication commemorating the convention. In view, however, of the heavy demands for the recommendations, the Association have published them in the form of a separate little booklet.

BOOKS RECEIVED

New Methods for Sheet Metal Work. By W. COOKSON. Fourth revised edition. *The Technical Press, Limited, 1 Justice-walk, Lawrence-street, London, S.W.3.* [16*s.* net.]

Electrical Trades Directory 1954. The Electrical Journal Blue Book. *Benn Brothers, Limited, Bouverie House, 154 Fleet-street, London, E.C.4.* (50*s.* post free.)

Information Theory. By PROFESSOR STANFORD GOLDMAN. *Constable and Company, Limited, 10 Orange-street, London, W.C.2.* (50*s.* net.)

Progress and Problems of the European Economy. Fifth Annual Report of the O.E.E.C. *O.E.E.C., Chateau de la Muette, 2 Rue André-Pascal, Paris* (16*e*); and *H.M. Stationery Office, Kingsway, London, W.C.2.* (14*s.*)

Applied Thermodynamics. By WILLIAM ROBINSON. Revised by JOHN M. DICKSON. Third edition. *Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2.* (40*s.* net.)

The Institution of Mining Engineers. Coal Economy at Collieries Symposium, 1952–53. *Offices of the Institution, Salisbury House, Finsbury Circus, London, E.C.2.* (20*s.*)

Les Terrains Perméables. By A. MAYER. Second edition. *Dunod, 92 Rue Bonaparte, Paris* (6*e*).

Lehrbuch des Stahlbetonbaues. By A. PUCHER. Second edition. *Springer-Verlag in Wien 1, Mölkerbastei 5.*

Performance and Efficiency Tests with Live Steam Injector. W.D. 2-10-0 and 2-8-0 Freight Locomotives. British Railways Locomotive Testing Bulletin, No. 7. *The British Transport Commission, 222 Marylebone-road, London, N.W.1.* (10*s.*)

Rocket Propulsion. By ERIC BURGESS. Second edition revised. *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (21*s.*)

Directory of Institutions Engaged in Arid Zone Research. *United Nations Educational, Scientific and Cultural Organization, 19 Avenue Kléber, Paris* (16*e*); and *H.M. Stationery Office, Kingsway, London, W.C.2.* (8*s.* 6*d.*)

Electrical Earthing and Accident Prevention. Edited by DR. M. G. SAY. *George Newnes, Limited, Tower House, Southampton-street, London, W.C.2.* (25*s.* net.)

Overseas Economic Surveys: Brazil. By WALTER GODFREY. *H.M. Stationery Office, Kingsway, London, W.C.2.* (5*s.*)

Ceramics: A Symposium. By A. T. GREEN and GERALD H. STEWART. *The British Ceramic Society, Queen's-road, Penkhull, Stoke-on-Trent.* (65*s.*; Members 45*s.*)

The Locomotives of R. E. L. Maunsell. By O. S. NOCK. *Edward Everard, Limited, Broad-street, Bristol, 1.*

Electronics. By A. T. STARR. *Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2.* (32*s.* 6*d.*)

Flood Control Politics. The Connecticut River Valley Problem, 1927-1950. By W. E. LEUCHTENBURG. *Harvard University Press, Cambridge, U.S.A.* (5 dols.). Distributed in Great Britain by *Geoffrey Cumberlege, Oxford University Press, Amen House, Warwick-square, London, E.C.4.* (40*s.*)

Basic Naval Architecture. By K. C. BARNABY. *Hutchinson's Scientific and Technical Publications, Stratford-place, London, W.1.* (35*s.*)

Chemical, Gas and Mining Engineering, Oil Prospecting and Production and Fuel Technology. "Careers for Men and Women" series No. 19. Issued by the Ministry of Labour and National Service. *H.M. Stationery Office, Kingsway, London, W.C.2.* (1*s.* 6*d.*)

Mechanics of Sawing: Band and Circular Saws. Forest Products Research Bulletin No. 30. *H.M. Stationery Office, Kingsway, London, W.C.2.* (1*s.* 6*d.*)

Hand Tools. Case Study Data on Productivity and Factory Performance. Prepared for the Foreign Operations Administration Productivity and Technical Assistance Division, by the United States Department of Labor. Distributed in Great Britain by the *British Institute of Management, Management House, 8 Hill-street, London, W.1.* (5*s.*)

LAUNCHES AND TRIAL TRIPS

S.S. "CLAN STEWART."—Single-screw cargo vessel, to carry twelve passengers, built by the Greenock Dockyard Co., Ltd., Greenock, for the Clan Line Steamers, Ltd., London, E.C.3. Last vessel of a series of four. Main dimensions: 476 ft. between perpendiculars by 66 ft. by 40 ft. 8 in. to upper deck; deadweight capacity, about 11,000 tons on a mean draught of 27 ft. 11½ in.; gross tonnage, about 8,162. Reaction steam turbines with double-reduction gears, to develop 9,400 s.h.p. at 108 r.p.m. and a speed of 16½ knots in service, constructed by Parsons Marine Steam Turbine Co., Ltd., Wallsend-on-Tyne; and two oil-fired steam-generating units constructed by Babcock and Wilcox, Ltd., London, E.C.4. Machinery installed by John G. Kincaid & Co., Ltd., Greenock. Trial trip, January 21 and 22.

M.S. "VIDALAND."—Single-screw cargo vessel, built and engined by Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, for Angfartygs A/B Tirfing-Svenska Orient Linien, Gothenburg, Sweden. Main dimensions: 400 ft. between perpendiculars by 57 ft. 8 in. by 25 ft. 3 in. to main deck; deadweight capacity, 5,800 tons on a draught of about 23 ft. 7 in. B. and W. seven-cylinder single-acting Diesel engine, developing 6,700 i.h.p. Speed, 16·5 knots, fully loaded. Delivered, January 28.

M.S. "PORT MONTREAL."—Single-screw cargo vessel, built and engined by Harland and Wolff, Ltd., Govan, Glasgow, for the Port Line, Ltd., London, E.C.3. Main dimensions: 440 ft. between perpendiculars by 64 ft. by 39 ft. 5 in. to shelter deck; gross tonnage, about 6,400. Harland-B. and W. seven-cylinder two-stroke opposed-piston heavy-oil engine. Delivered, February 4.

M.S. "OREOSA."—Single-screw vessel for the carriage of iron ore, built and engined by William Gray & Co., Ltd., West Hartlepool, for Ore Carriers, Ltd., London, E.C.3. Second vessel of an order for six. Main dimensions: 407 ft. between perpendiculars by 57 ft. by 33 ft. 4 in.; deadweight capacity, about 9,000 tons on a draught of 25 ft. 6 in. Two five-cylinder Gray-Polar oil engines, coupled to a single shaft through Vulcan hydraulic clutches and reduction gearing, supplied by David Brown and Sons (Huddersfield), Ltd., Huddersfield. Speed, 12 knots. Launch, February 4.

M.S. "TINTAGEL CASTLE."—Single-screw cargo vessel, with accommodation for twelve passengers, built and engined by Harland and Wolff, Ltd., Belfast, for the Union-Castle Mail Steamship Co., Ltd., London, E.C.3. Second vessel of an order for two. Main dimensions: 465 ft. between perpendiculars by 65 ft. 6 in. by 41 ft. 6 in. to shelter deck; gross tonnage, 7,450. Eight-cylinder double-acting two-stroke oil engine. Launch, February 4.

S.S. "CANNING."—Single-screw tug, built by Cochrane and Sons, Ltd., Selby, Yorkshire, for the Alexandra Towing Co., Ltd., Liverpool. Main dimensions: 92 ft. 6 in. between perpendiculars by 25 ft. 6 in. by 12 ft. 6 in.; gross tonnage, 200. Triple-expansion steam engine, developing 800 i.h.p., and one oil-burning boiler, constructed by Charles D. Holmes & Co., Ltd., Hull. Launch, February 5.

M.S. "ANTERIORITY."—Single-screw oil tanker, built by the Goole Shipbuilding and Repairing Co., Ltd., Goole, for F. T. Everard and Sons, Ltd., London, E.C.3. Main dimensions: 260 ft. by 41 ft. 6 in. by 17 ft. 9 in.; deadweight capacity, about 2,500 tons. Newbury Diesel engine, developing 1,200 b.h.p. at 250 r.p.m., constructed by the Newbury Diesel Co., Ltd., Newbury, Berkshire. Launch, February 8.

S.S. "HERTHA."—Single-screw oil tanker, built and engined by the Blythswood Shipbuilding Co., Ltd., Scotstoun, Glasgow, for Skibsaktieselskapet William Hansens Rederi, Bergen, Norway. Main dimensions: 305 ft. by 44 ft. by 20 ft. 3 in. to upper deck; deadweight capacity, about 3,500 tons on a draught of 18 ft. 6 in. Triple-expansion steam engine and two oil-burning Scotch boilers. Speed, 11½ knots. Trial trip, February 11.

M.S. "AUBY."—Twin-screw vessel for the carriage of cargo and first-class and unberthed passengers, built by Henry Robb, Ltd., Leith, for the Sarawak Steamship Co., Ltd., Kuching, Sarawak. Main dimensions: 212 ft. between perpendiculars by 44 ft. by 21 ft. to upper deck; deadweight capacity, about 1,170 tons on a mean draught of 11 ft. 9 in. Two four-stroke non-reversing Diesel engines, each coupled direct to propeller shafting through oil-operated reverse-reduction gears. The engines can deliver a total of 1,018 b.h.p. at 500 r.p.m., with a 2 to 1 reduction-gear ratio. Engines constructed by Ruston and Hornsby, Ltd., Lincoln. Trial trip, February 12.

The Engineering Outlook—10

LIGHT ELECTRICAL AND CABLE INDUSTRIES

DEMAND FOR DOMESTIC APPLIANCES

IN the light electrical industry, output is now generally higher than it was a year ago. The Coronation and the reduction of purchase tax in the last Budget induced the British public to spend more freely on domestic electrical appliances, and some relaxation of import restrictions abroad has helped export sales. Manufacturers in the more prosperous sections of the industry are reasonably confident about their future prospects, but there is no rash optimism. Markets are keenly competitive; at home, the Government announcement that no changes in purchase tax are contemplated should prevent the seasonal pre-Budget drop in sales, but buyers are showing increasing discrimination in their choice of competing brands, and shortage of purchasing power makes them weigh carefully the relative advantages of different types of household appliances.

Certainly, the recovery in sales has been very uneven, as may be seen from the accompanying graphs on this and the following page. While, for example, as may be seen from the three graphs at the foot of this page, the output of vacuum cleaners in 1953 was higher than in 1952, the output of electric kettles and electric irons was significantly lower. The inverse relationship, shown in the graphs at the top of page 332, between the sales of television sets and radio receivers is to be expected – though, in the latter months of 1953, the demand for both types of equipment was buoyant. The boom in television sales in the first half of 1953 may well have helped to retard the recovery in sales of such things as washing machines and cookers, shown in the next two graphs. In both these cases the output was then lower than in the first half of 1952. Increased sales in the second half of 1953 eventually carried production above the 1952 totals, but it was still below the level of 1951.

Exports of domestic electric appliances had improved greatly by the end of 1953, but the total for the year was lower than in 1952 (see Table I, above, taken from the *Trade and Navigation Accounts*), and sales resistance and continuing import restrictions make further progress difficult.

Governments anxious to build up manufacturing industries in their own countries tend to consider light electrical equipment as particularly suitable, and British manufacturers are finding it increasingly necessary to set up their own factories abroad in order to circumvent protective barriers. One of the latest moves in this direction is the establishment by Hoover, Limited, of a manufacturing subsidiary, Hoover Industries Proprietary, Limited, in Australia. Import restrictions have actually eased considerably in Australia and New Zealand, and British exports to these countries should increase in 1954.

Price competition may be expected to intensify in 1954. Already, substantial cuts have been made in the prices of a variety of domestic electric appliances. In October, for example, the General Electric Company reduced the prices of a range of kettles, hair-dryers and irons; in December, Electrical and Musical Industries, Limited, cut considerably the price of almost all the items in the range of H.M.V. household appliances, which includes irons, fires, toasters and hair-dryers. Competition is also bringing the consumer the benefit of improved designs; manufacturers are introducing new and improved models more frequently, and the success of a new model by one maker quickly brings out a range of competing models from others. The method by which the market for small electric washing machines has been developed in the past year is an outstanding case in point.

Manufacturers, moreover, are tending to reduce their dependence on a limited range of appliances by entering new fields, and this again increases competition and encourages new developments. For example, Hoover, Limited, who have introduced several new products in the past few years, are now producing electric irons. Pye, Limited, who had long concentrated on the manufacture of radio and television equipment, are now also making household appliances, and are extending their interests to the manufacture of gramophone records through the Nixa Record Company. The latter had formerly confined their activities to making long-playing records of classical music, but popular works are now to be offered at prices in line with those of the E.M.I. and Decca groups. In general, the buyer's market, by putting a premium on enterprise and efficiency, is creating a healthy light electrical industry, technically ahead of overseas rivals.

PROGRESS IN ELECTRONICS

Nowhere has technical progress been more rapid than in the manufacture of radio and television equipment. The scope of this industry is being steadily widened, and it is estimated that only about 50 per cent. of the products of the component manufacturers are for domestic receivers, compared with 90 per cent. before the war. The tendency in industry generally to limit capital investment has not encouraged industrial applications of electronic equipment; nevertheless, progress has been rapid, and industrial productivity is being steadily raised by the adoption of electronic control gear, detectors, heating appliances, communications equipment, etc.

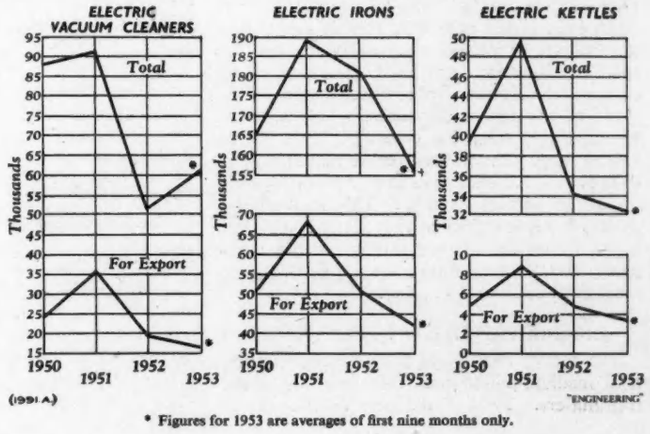
The production of electronic equipment for defence has only recently reached the peak, and, despite the cuts in the re-armament programme, is expected to continue at a rate of £3·6 millions a month during 1954. Most of the new weapons being developed for the Services owe their greater effectiveness to the progress of electronic research, and the large companies, who have had the major share of the contract work, do not expect any drastic reduction in Government orders in the next few years. The re-armament programme has not required mass-production work on any scale, and the output of domestic receivers has not been affected. It has prevented some companies from giving their full attention to the development of industrial electronic equipment, but Government aid in providing finance, machines and additional capacity has kept interference with civilian production at a minimum.

Radar equipment is being supplied to civilian operators on an increasing scale. The Decca Navigator Company claim that the number of ships fitted with their equipment now exceeds 3,000. In the space of four years, about 70 per cent. of British shipping on coastal and short-sea routes has been equipped with Decca radar; by the middle of 1953, about 60 Canadian vessels were using Decca navigational aids, and in July the Decca Navigator Company set up a Canadian subsidiary, one of whose objects was to interest the Canadian Government in setting up the Decca Radar system on both coasts.

The industrial use of television is also being rapidly extended. Pye, Limited, who have been very active in this field, are now offering an improved version of their industrial television equipment, first demonstrated in 1952, when it was used in a bank for checking records stored some miles away. Since then, it has been used

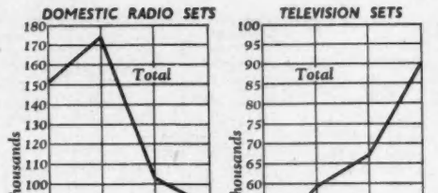
TABLE I. *United Kingdom Exports of Light Electrical Goods and Apparatus.*

	Value (£1,000)		
	1951	1952	1953
Wireless apparatus:			
Domestic radio-receivers ..	4,765	4,436	3,518
Transmitting apparatus	5,707	7,963	11,001
Valves, complete	3,734	3,615	2,200
Telephone and telegraph apparatus	15,521	17,119	17,523
Electric-light bulbs, complete ..	1,569	1,359	1,087
Electric-light appliances and accessories	4,430	5,306	5,026
Batteries, primary, complete ..	2,180	2,251	2,264
Accumulators	4,965	4,597	3,090
Electrical cooking and heating appliances	4,237	4,086	2,706
Electrical instruments	4,385	4,799	4,607
Electro-medical apparatus ..	1,454	1,283	1,218
Refrigerating machinery	14,000	14,113	12,864
Vacuum cleaners	3,515	2,286	1,809
Total	70,462	73,213	68,913

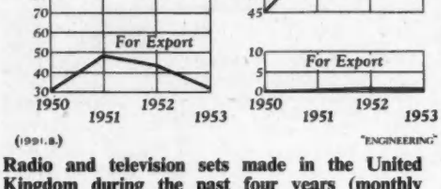


Domestic electrical appliances made in the United Kingdom during the past four years (monthly averages).

* Figures for 1953 are averages of first nine months only.



Radio and television sets made in the United Kingdom during the past four years (monthly averages).



Domestic electric washing machines and electric cookers made in the United Kingdom during the past four years (monthly averages).

in atomic-research stations, oil refineries, etc. Considerable progress in underwater television has been made both by Pye, Limited, and by Marconi's Wireless Telegraph Company. A new Pye underwater camera, which can be operated down to 3,000 ft., was used in locating the wreck of the Comet off Elba. The Marconi-Siebe-Gorman underwater camera has been fitted with a periscopic lens, which can be operated by remote control and permits the camera to scan a large area of the sea bed without having to be moved. It is claimed that many of the difficulties of televising under water in bad weather have been overcome.

The output of domestic television receivers and transmitting equipment increased considerably in 1953. There are now about three million television broadcast receiving licences current in the United Kingdom, compared with two millions at the beginning of 1953 and 1·3 millions at the beginning of 1952. The output of television receivers in 1953 reached the record total of 1·08 millions, 269,000 more than in 1952.

An even higher output in 1954 is well within the bounds of probability. Sales are still far short of saturation point in the areas served by existing television receivers, and, in view of the plans of the British Broadcasting Corporation for extending television coverage, it should be two or three years at least before manufacturers of television receivers have to rely predominantly on a replacement demand. This is negligible as yet, but it is estimated that about 35,000 sets in use are between six and seven years old, while nearly 500,000 were four years old or over, and most of these have 9-in. tubes.

HIGHER OUTLAY ON TELEVISION

The B.B.C. announced plans in July for five new medium-power and two new low-power transmitters. Two of the new medium-power stations are replacements for the temporary stations in Northern Ireland and North-Eastern England; the others are to serve South Devon, Aberdeen and the Isle of Wight. The two low-power stations will be built in the Isle of Man and the Channel Islands. More recently it was announced that an additional six transmitters are proposed for East Anglia, Inverness, Londonderry, Towyn and Carlisle. The new television station at Crystal Palace will be the most powerful in the world, and when it is completed in two years' time the B.B.C. will have brought their television services within reach of 98 per cent. of the population of the United Kingdom. Contracts for two vision and two sound transmitters have been placed with Marconi's Wireless Telegraph Company. The total cost of the 14 television stations now in course of construction or planned will be about £2·3 millions.

Final decisions have still to be made about the future of commercial television in the United Kingdom, but it should not be long before the three stations proposed for London, the Midlands and South Lancashire are established. Two channels in Band III have been allocated, and Mr. L. D. Gammans, the Assistant Postmaster General, has assured Parliament that the Government are keeping in continuous contact with the radio industry so that commercial television can make a good beginning. A start cannot be made, however, until a new corporation is formed. Under the scheme approved by the Television Advisory Committee it is proposed to set up a controlling body who will own the commercial transmitting stations and will have power to censor the broadcast material of the "programme companies." These companies will actually control the programmes, so that, while advertisements will be broadcast, there is no question of "sponsoring" by the advertisers.

As Mr. Gammans has pointed out, it would be necessary to raise the annual licence fee from £2 to about £5 if the additional services had to be financed by licence revenue. The £2 licence has proved inadequate even for the present B.B.C. programme and is now to be raised to £3. In fact, the B.B.C. have stated that a fee of £3 10*s*. would have been necessary to cover the outlay on television in 1953. Even if the carefully controlled television advertising attracted only about 5 per cent. of the £200 millions spent annually on advertising, this would be a very useful revenue for the new corporation and the programme companies. Objections to commercial television may prove academic if, in the next few years, powerful Continental stations are set up, which will be capable of bringing sponsored programmes to British homes. Television services are already established or about to be established in at least seven Continental countries, and Sir Ian Jacob, the Director-General of the B.B.C., has said that the interchange of programme should go forward with increasing impetus.

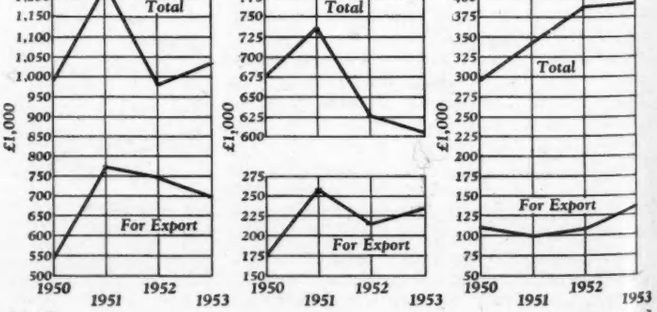
The approach to financing television in the United States is directly opposed to the British. United States broadcasting companies are now seeking to have their advertising revenues supplemented by a system of direct subscription. Three separate meter systems have been devised, whereby viewers will buy the programmes they want to see, but prolonged tests are necessary before the approval of the Federal Communications Committee can be given. Colour television in the United States is already a commercial proposition. The "incompatible" system introduced by the Columbia Broadcasting Company in 1950 was a failure, but a new "compatible" system, which allows colour transmission to be received in black and white on ordinary receivers, is now being used by both the C.B.C. and the National Broadcasting Company. Although the cost of the colour receivers is high, it is hoped that up to 100,000 will be sold in 1954. Mass production will bring down prices and the C.B.C. claim that, by the end of 1955, colour tubes will cost only about 30 per cent. more than ordinary tubes of comparable size.

RISING EXPORTS OF TELEVISION EQUIPMENT

Considerable progress has been made with the development of colour television in the United Kingdom. Pye, Limited, who first demonstrated it as long ago as 1949, provided three colour cameras for televising the Coronation, which projected the scene to a children's hospital. Unless, however, colour television is introduced into service in the fairly near future, there is a danger that United States manufacturers of television equipment will establish a lead which may be hard to overtake. They are already promising colour television equipment to potential overseas customers for delivery in two years' time, so that the consequences for the rising British trade in television equipment may be serious. Marconi's Wireless Telegraph Company have exported television equipment valued at about £1 million since the war to North and South America and the Far East, as well as to a number of European countries, and Pye, Limited, have found markets in many countries, including the United States, Belgium and Japan.

Recent export orders include a complete television broadcasting vehicle placed with Marconi's by the Swiss broadcasting authorities, and equipment for the first Belgian station placed with Pye, Limited. This has to be dual-standard so that programmes may be received both by receivers owned by Flemish speakers, which are adapted to the 625-line system of the Lopeck station in the Netherlands, and receivers owned by French speakers, which are adapted to the 819-line system of Lille.

Pye, Limited, have also prepared the studio and equipment which will transmit the first New Zealand television services. Exports of television receivers as well as transmission equip-



Refrigerators of various types made in the United Kingdom since 1950 (monthly average values).

ment have already begun, but a large receiver market is not automatically opened up for British manufacturers in those countries in which they have installed transmitting equipment. In many of these markets there are already well-established radio-manufacturing industries, and the manufacture of television receivers should not be beyond their powers.

In Italy, regular transmission services are now being broadcast from Rome, Milan and Turin, much of the equipment being British-made. British receivers are being made under licence in Italy, but large imports of British receivers are unlikely. Italian manufacturers hope to produce about 50,000 receivers in 1954, and are receiving considerable official encouragement. Radio-televisione Italiana, a quasi-Government institution, have been paying advertising expenses on Italian-made television sets in order to encourage sales, and thus to increase the subscription revenue to their broadcast services. They have also been reimbursing the manufacturing tax on such sets when they are sold, so that, in effect, the domestic television manufacturers are subsidised. German manufacturers are doing their utmost to capture a large share of the European market for television receivers, which sell at between £80 and £100. Their sets are designed so that they can be tuned to all the existing international television channels. The output in 1953 was about 80,000 units.

The British radio manufacturing industry is not neglecting sound broadcasting. The output of radio receivers in 1953, as might be expected, was well below the total for 1951, but there was a strong revival of demand in the second half of the year, which carried the output for the year to over a million units, only 200,000 fewer than in 1952. The B.B.C. proposal to broadcast frequency-modulated programmes in the very-high-frequency bands, moreover, may eventually be expected to stimulate demand. These proposals have met with some opposition, but the Television Advisory Committee are satisfied that, though an unwelcome complication, this is " the only means of overcoming the difficulties which arise from the shortage of medium wave-lengths and increasing competition from Continental broadcasting stations." Nevertheless, it remains to be seen whether the public will be prepared to pay 30 per cent. more for a receiving set incorporating v.h.f. circuits. Broadcast services using v.h.f. have already been operated in many countries, usually with very little success, and one reason for their failure has been the high price of the receivers. A major criticism of the B.B.C. proposals is that, because of the heavy outlay, estimated at £2 millions, on the large number of new stations required, the introduction of colour television may be retarded. Orders for £450,000 have already been placed, however, with Marconi's Wireless Telegraph Company and Standard Telephones and Cables, Limited, for 50 v.h.f. transmitters.

IMPROVED TELECOMMUNICATIONS

The contribution which the radio manufacturing industry is making to increase the efficiency of telecommunications is considerable, and this has helped the British telephone and telegraph industry to maintain their supremacy in foreign markets. Competition, particularly from Germany and Japan, is increasing, however, and in a buyer's market, the telecommunications industry will be fortunate if it can increase exports above the total of £17·5 millions achieved in 1953. German manufacturers have been very successful in South America; the Siemens Company, for example, secured an order in 1953 valued at £8·5 millions for the installation of a telephone system in Venezuela.

At home, the volume of business is limited only by the investment outlay which the General Post Office is prepared to undertake. The rate at which telephones are being installed has been greatly increased, but is still inadequate. There are still over 400,000 potential subscribers on the waiting list, a reduction of only 60,000 in twelve months. In some cases, people have been waiting six years for a telephone. Nevertheless, three million new connections have been made in the past three years, and this rate of installation, half as great again as before the war, has brought the number of telephones in use to more than six millions. Mr. Gammans has stated that £116 millions would be spent on telephone equipment in the next few years, and that it was hoped to reduce considerably the number of people waiting for telephones.

The agreement recently signed by the G.P.O., the American Telephone and Telegraph Company, and Canadian Overseas Telecommunication for the first transatlantic telephone cable is obviously an important event in the history of telecommunications. Hitherto, trans-atlantic communication has had to be by telegraph cable or radio-telephone, but, as a result of research and development work in the United Kingdom and in the United States, it has been possible to plan by far the longest submarine telephone cable ever laid. The cost of the project for linking Oban with Sydney Mines in Nova Scotia and with Clarenville in Newfoundland will be about £12·5 millions. The United States will meet 50 per cent. of the cost, the United Kingdom 41 per cent. and Canada 9 per cent. The whole of the British contribution will be in kind; the cable will be made in the United Kingdom, and will be laid by the British cable ship Monarch, which is being specially adapted. The execution of this work will make heavy demands on the capacity of the British manufacturers of submarine cables, but Submarine Cables, Limited, who are the largest producers of this equipment in the world, have recently set up new manufacturing facilities.

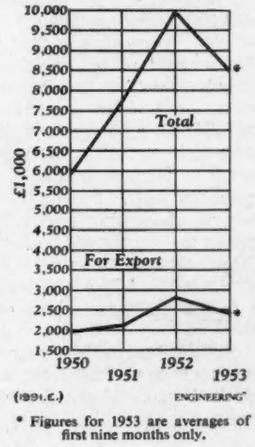
Laying should begin in the summer of 1955 and should be completed by the end of 1956. One disappointing feature of the agreement is that an American system of one-way repeaters is to be used, and this necessitates laying two cables 2,250 miles long. British two-way repeaters of more advanced design are available, and, had these been employed, only one cable would have been required. They have not, however, been adequately tested in deep water, and their use will be limited to the comparatively short stretch between Newfoundland and Nova Scotia.

TABLE II. United Kingdom Exports of Electric Wires and Cables.

	Quantity (Tons)			Value (£1,000)		
	1951	1952	1953	1951	1952	1953
Telegraph and telephone cables and wires:						
Submarine	4,338	4,708	4,932	559	725	921
Other	21,553	26,328	26,041	5,819	8,239	7,660
Other types of wires and cables:						
Paper-insulated:						
To British West Africa	697	775	1,259	145	185	301
„ Union of South Africa	3,080	2,457	2,152	590	592	650
„ India	4,939	12,331	9,657	938	2,948	2,263
„ Malaya	2,121	2,471	2,090	387	623	502
„ Hong Kong	354	1,030	781	74	268	178
„ Australia	5,350	6,973	5,950	1,049	1,651	1,458
„ New Zealand	917	929	2,534	179	232	596
„ Other Commonwealth countries and the Irish Republic	7,651	6,953	10,901	1,632	1,735	2,636
„ Norway	1,006	341	450	211	88	98
„ Portugal	359	307	28	76	74	7
„ Turkey	489	930	438	93	219	137
„ Egypt	1,131	802	214	223	191	54
„ Other foreign countries	4,813	6,664	9,290	1,076	1,791	2,133
Total	32,907	42,963	45,744	6,673	10,597	11,013
Rubber-insulated:						
To Union of South Africa	1,405	1,510	639	570	646	285
„ British East Africa	966	666	301	466	345	156
„ India	1,394	1,550	2,015	465	645	799
„ Pakistan	1,303	959	407	533	460	155
„ Malaya	1,288	1,133	811	498	516	315
„ Hong Kong	805	739	419	318	337	151
„ Australia	302	650	259	135	270	77
„ New Zealand	1,534	1,548	1,444	618	778	517
„ Other Commonwealth countries and the Irish Republic	2,999	3,548	3,554	1,223	1,692	1,375
„ Foreign countries	3,865	3,749	3,119	1,523	1,776	1,173
Total	15,861	16,052	12,968	6,349	7,465	5,003
All other:						
Cotton, silk or artificial-silk insulated	1,535	1,690	1,306	695	885	662
Enamel, glass or asbestos insulated	2,023	1,562	1,575	987	935	976
Other	5,657	6,262	6,742	2,479	3,323	3,177
Total	9,215	9,514	9,623	4,161	5,143	4,815
Grand Total	83,874	99,565	99,308	23,561	32,169	29,412

UNDER-WATER POWER CABLES

The use of under-water cables for carrying electrical power is being extended. Experimental lengths of power cable were laid under the English Channel in July as part of the sea trials for a projected link between the British and French electricity supply systems. The cost of the project, if finally approved, will be about £4·5 millions, to be shared equally by the British Electricity Authority and Electricité de France. Four heavy cables will be required, capable of carrying three-phase current at 132 kV. British Insulated Callender's Cables, Limited, have recently announced the receipt of an order, valued at £1·07 millions, from the British Columbia Electricity Company for supplying and laying 77 miles of 138,000-volt gas-filled cable



Electrical wires and cables made in the United Kingdom since 1950 (monthly average values).

* Figures for 1953 are averages of first nine months only.

across the Georgia Strait from the mainland to Vancouver Island. This route requires the use of continuous lengths of cable 17 miles long, laid at depths of up to 600 ft. Four single-core cables, with a total weight of more than 3,000 tons, will be laid, and, when in operation in 1956, these will be transmitting electricity under water at a higher voltage and a higher carrying capacity than any other installation in the world.

Despite this growing use of under-water power cables, a different solution has been preferred for linking the Sicilian power system with that of Italy. A stretch of cable 11,722 ft. long, said to be the longest in the world, is to be slung without intermediate support between two steel towers, 728 ft. high, on either side of the Straits of Messina.

CABLEMAKERS' UNCERTAINTIES

The demand for heavy power cables continues at a high level. As will be seen from Table II, taken from the *Trade and Navigation Accounts*, exports of paper-insulated cables reached £11 millions in 1953, nearly £600,000 more than in 1952. Deliveries to the British Electricity Authority have also been rising, and may be expected to increase further in step with the programme for increasing generating capacity. Cable manufacturers and the B.E.A. have been co-operating closely in research and development work; for example, tests have been conducted with short trial lengths of 275,000-volt cables of the oil-filled and gas-pressure types at a temporary testing station, to gain service experience which will assist in the design of any cable installations that may be required in the Supergrid.

The demand for lighter cables has not been so well maintained as for the heavier types. As may be seen from the graph opposite, the total output of wires and cables in 1953 was considerably below the level of 1952. The buyer's market was made all the more difficult by two exceptional factors. The price of copper was generally expected to drop when the free market opened on August 5, and, in consequence, the sales of cables were depressed for many months in advance. The date of resumption of free trading in copper coincided almost exactly with the introduction of revised British Standard Specifications for rubber-covered cables. It was generally understood, well before the event, that these would mean a reduction in selling prices, since they would reduce manufacturing costs. As a result, many buyers withheld their orders till prices fell on August 1.

In the general uncertainty about markets the industry is very anxious to learn what action the Government propose to take on the report of the Monopolies Commission. Since their recommendations may mean some changes in the organisation of the industry, which could affect the sales effort at a critical time, it is unfortunate that 20 months have elapsed since the publication of the report without any pronouncement on Government policy. Complaints about monopoly have not been confined to the United Kingdom. In a report published in Canada by the Special Commissioner under the Combines Investigation Act, it is alleged that a combine exists in the distribution of electrical wire and cable products. Nine cable manufacturers and one selling organisation are named as participants, and one is said to account for more than 90 per cent. of the value of the output of cables in Canada. Imports, as a percentage of the Canadian production, have been relatively small. Complaints were investigated by customers who complained that they were receiving identical tenders from all manufacturers. This, according to the Special Commissioner, had " vitiated and made a mockery " of the system of competitive bidding. He found that the companies had made a studied effort to conceal their activities and that their price lists, in effect until late in 1951, showed " a calculated attempt to disguise the fact that the net prices in each company's book were identical."

These findings, of course, do less than justice to the benefits which the customer may derive as a result of the stability which an organised system of marketing makes possible, but the North American consumer, perhaps even more than the British, is very much alive to the dangers of monopoly, though these are more often potential than actual.

The export outlook, for some types of British wires and cables, is still bright. A hopeful possibility is the growth of trade with countries within the Russian sphere of influence. Aberdare Cables, Limited, have already completed delivery of an important Russian order for 2,000 m. of cable, received in July. Prospects for rubber-insulated cables are weakest; the growth of manufacturing industries abroad will make it increasingly difficult for British cablemakers to maintain their exports. There is at least a partial compensation, however, in the rising revenue from overseas subsidiaries, for British cablemakers were among the first to establish factories abroad. As in the light electrical industry, difficult markets are a challenge rather than a cause for despondency. There is every prospect of a high level of output in 1954.

SAFETY IN THE AIR

"CRASHWORTHINESS" AND ACCIDENT INVESTIGATIONS

British standards of airworthiness, meteorological services and air traffic control, airline operation, maintenance and inspection compare favourably with those of any country in the world, and accidents resulting from faulty design, construction or servicing are rare. Nevertheless, the chances of survival in the lesser kind of accident such as over- and under-shooting, belly landings, ditching and low-speed crashes can be improved. This, briefly, is the conclusion to be drawn from the second of the three Cantor lectures on " Safety in Transport," which was given before the Royal Society of Arts on Monday, March 1, by Air Commodore Sir Vernon Brown, C.B., O.B.E. (Retd.), who was, until the end of 1952, Chief Inspector of Accidents to the Ministry of Civil Aviation.

Apart from providing protection from collisions in the air or flying into mountains, the Air Commodore said that no drastic improvements to airworthiness requirements could be foreseen at present, but much could still be done to improve crashworthiness. Means of preventing, detecting and extinguishing fires were under continuous research, but if a crash resulted in the destruction of the aircraft's fuel tanks and the release of hundreds of gallons of fuel, some of which might be sprayed on to red-hot exhaust pipes, the problem was difficult to overcome. A major fire, however, could only occur if a large quantity of fuel was released. Fuel tanks therefore, should be capable of withstanding high impact loads, should not be placed in a vulnerable position, and should be as far as possible from known sources of ignition. Moreover, there should not be an array of pipelines, pumps and excrescences on the underside where crash impact was most likely to cause pamage.

BACKWARD-FACING SEATS TO WITHSTAND 20*g*

In crash landings, head injuries were the most frequent causes of death. If the seats and the airframe structure were constructed to withstand an acceleration of at least 20*g*, and if, in addition, the seats faced backwards and were provided with adequate head, back and leg protection, the fatalities and serious injuries in a survivable accident could be reduced to an almost negligible quantity.

If it should be necessary to alight in the sea, the aircraft should be able to float for sufficient time to allow its occupants to be evacuated. An emergency exit was of no use if it could not be easily opened, if it was too small for a passenger of abnormal build to use, and if it involved a drop of 10 or 20 ft. on to hard ground or into the sea. Exits should not jam as a result of fuselage distortion; the time had come when a standard method of opening should be adopted, so that any passenger should be able to open the door in an emergency, perhaps in the dark.

CAUSES OF PILOT ERROR

Cockpit ventilation, noise, vibration, temperature, lack of sleep, alcohol poisons, colds, domestic worries, etc., might affect the pilot's responses to audible and visible warnings, and the accident investigator had to determine, in the case of pilot error, why that error was made. Human engineering studies might help to determine the limits to which an individual could make use, in an emergency, of what the designer had given him. Dr. Ross McFarland, of the Harvard School of Public Health, had suggested recently that aircraft designers should not assume that a pilot was always at peak efficiency, and that they should bear in mind the limitations of older men.

An aircraft might encounter storms, rain, hail, icing, snow, fog, or lightning. Although accidents had been caused by loss of control in such conditions, Sir Vernon did not know of a single fatal lightning strike. Early warning of glazed icing, which was rare, was usually experienced.

The Air Commodore then showed a number of slides illustrating how the sequence of failure could be deduced from the type of fracture – whether tensile or compressive, fatigue, etc. – and from marks on the surface, such as the damage caused by a bird striking the wing leading edge, or smear marks extending across the broken portions of a surface, indicating that the surface had been struck by something before it broke.

EXCHANGE OF INFORMATION

The passing of information among Government departments, designers, manufacturers and operators was important. There were two aspects: (1) the reporting of every accident and incident, and (2) the dissemination of technical information. Pilots could seldom be persuaded to report their experiences in writing, possibly because of fears of disciplinary action. If a system of anonymous reporting could be adopted, some good might result. As regards the exchange of technical information, in this country it was agreed during the second World War that such knowledge should be pooled in the common interest, and such co-operation still continued between the Ministry of Supply, the fighting Services, the Ministry of Civil Aviation, the Air Registration Board, the designers and operators. The experimental establishments, in particular the Royal Aircraft Establishment, were available to all for advice and guidance.

REINFORCED ANNULAR PLATES

DESIGN FOR MINIMUM WEIGHT UNDER LATERAL LOADING

By Raymond Hicks, M.SC.

This article deals with a simply supported annular plate reinforced around its inner boundary by a ring of the same material. The plate carries a concentric lateral load which is uniformly distributed around the hole as shown in Fig. 1.

For a given applied load the maximum stress in the plate depends on its thickness and the cross-sectional dimensions of the reinforcement. It therefore follows that for a given maximum stress in the material the necessary thickness of plate and the weight of the structure (that is, of plate plus reinforcement) are controlled by the cross-sectional dimensions of the reinforcement.

In this analysis expressions are developed for the cross-sectional dimensions of the reinforcement which make the weight of the structure a minimum when these dimensions are kept within limits which are considered practicable. It is shown that the effect of suitably reinforcing the plate is to reduce the necessary weight of the structure by about 20 per cent. in some cases, and that, for a reinforcement having a given bending stiffness in the plane of the plate, the weight of the structure is a minimum when the maximum stress in the reinforcement is the same as the maximum stress in the plate. Possible applications of reinforcement used to decrease the weight of a structure are to be found in aircraft design.

It is worth noting that the method adopted in solving this problem can be applied to plates having other types of symmetrical loading; furthermore, plates with built-in boundaries can also be dealt with in a similar manner.

THEORETICAL ANALYSIS

If P is the total concentric load carried by the plate, the radial shear per unit length acting on the plate at a distance r from the centre of the hole is

$$Q_r = \frac{P}{2\pi r}. \quad . \quad . \quad (1)$$

At the junction of the reinforcement and plate the radial shear becomes

$$(Q_r)_b = \frac{P}{2\pi b}. \quad . \quad . \quad (2)$$

The external shear and radial moment per unit length acting on the inner boundary of the plate are shown in Fig. 2. The magnitude of the radial moment M depends on the unknown cross-sectional dimensions of the reinforcement.

The deflection surface of the plate is given by the following equation (see, for example, Timoshenko[1], page 55).

$$\frac{d}{dr}\left[\frac{1}{r}\frac{d}{dr}\left(r\frac{dw}{dr}\right)\right] = \frac{P}{2\pi Dr}, \quad . \quad (3)$$

where w is the deflection of the plate, and $D = \frac{E h^3}{12(1-\nu^2)}$, where E is Young's modulus, ν Poisson's ratio, and h the thickness of the plate.

The solution of equation (3) is

$$w = \frac{P r^2}{8\pi D}\left[\log\frac{r}{a} - 1\right] + \frac{A r^2}{4} + B\log\frac{r}{a} + C, \quad . \quad . \quad . \quad (4)$$

where A, B and C are constants of integration.

For a simply supported plate, the boundary conditions are

$$\left.\begin{aligned} M_r &= 0 \text{ at } r = a \\ M_r &= M \text{ at } r = b \\ w &= 0 \text{ at } r = a \end{aligned}\right\}, \quad . \quad (5)$$

where M_r is the radial moment in the plate and is given by

$$M_r = -D\left(\frac{d^2w}{dr^2} + \frac{\nu}{r}\frac{dw}{dr}\right). \quad . \quad (6)$$

From equations (4), (5) and (6) the following expression is obtained for the deflection surface of the plate

$$w = \left\{\frac{P r^2}{8\pi D}\log\frac{r}{a} + \frac{P}{16\pi D}\left(\frac{3+\nu}{1+\nu}\right)(a^2 - r^2) - \frac{b^2 M (a^2 - r^2)}{2D(1+\nu)(a^2 - b^2)} - \frac{P b^2 (a^2 - r^2)}{8\pi D (a^2 - b^2)}\log\frac{b}{a} + \frac{M a^2 b^2 \log\frac{r}{a}}{D(1-\nu)(a^2 - b^2)} + \frac{a^2 b^2 (1+\nu) P \log\frac{b}{a}\log\frac{r}{a}}{4\pi D(1-\nu)(a^2 - b^2)}\right\}. \quad (7)$$

The reinforcement has a rectangular cross-section which is chosen so that it has the greatest bending stiffness in a radial plane which is perpendicular to the plane of the plate. In order to keep the cross-sectional dimensions of such a reinforcement within practical limits the radius of the hole must be large compared with the width of the reinforcement. It therefore follows that the diameter of the reinforcement measured to the centre of its cross-section can be taken as being equal to the diameter of the hole. Thus, for equilibrium of an element of the reinforcement subtended by an angle $d\theta$, it is found that

$$\eta = b M, \quad . \quad . \quad (8)$$

where η is the bending moment acting on a cross-section of the reinforcement.

For bending compatibility around the curve $r = b$, a radial cross-section of the reinforcement must rotate through an angle equal to the slope of the plate at $r = b$. The strain in the top and bottom fibres of the reinforcement is therefore given by

$$\epsilon = -\frac{d}{2b}\left(\frac{dw}{dr}\right)_{r=b}, \quad . \quad (9)$$

since $\epsilon = \dfrac{\text{increase in radius of fibres}}{\text{original radius of fibres}}$.

The negative sign has been inserted in equation (9) because the slope of the plate is negative. From the simple theory of bending the strain in the top and bottom fibres of the reinforcement is given by

$$\epsilon = \frac{6\eta}{t d^2 E}, \quad . \quad . \quad (10)$$

where t is the thickness of the reinforcement and d its depth.

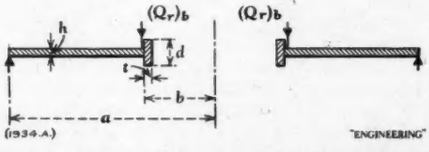


Fig. 1 Annular plate, supported at the periphery, carrying a concentric load uniformly distributed around the hole.

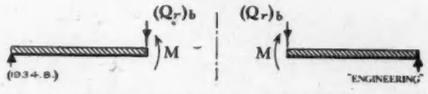


Fig. 2 The external shear and radial moment per unit length acting on the inner boundary of the plate.

From equations (7), (8), (9) and (10), the compatibility equation becomes

$$\frac{M b h^3}{t d^3 (1-\nu^2)} = \left\{-\frac{P}{4\pi}\log\frac{b}{a} + \frac{P}{4\pi(1+\nu)} - \frac{b^2 P \log\frac{b}{a}}{4\pi(a^2 - b^2)}\left[1 + \frac{a^2}{b^2}\left(\frac{1+\nu}{1-\nu}\right)\right] - \frac{M a^2 b}{(1-\nu)(a^2 - b^2)}\left[\frac{1}{b} + \left(\frac{1-\nu}{1+\nu}\right)\frac{b}{a^2}\right]\right\}. \quad . \quad . \quad . \quad (11)$$

This expression gives M in terms of the dimensions of the structure and the elastic constants for the material. For convenience, let

$$M = \frac{K(1-\nu)P(a^2 - b^2)}{8\pi a^2} - \frac{(1+\nu)P}{4\pi}\log\frac{b}{a}, \quad . \quad . \quad . \quad (12)$$

where K is a parameter which can have positive or negative values.

From equations (11) and (12)

$$t d^3 = \frac{h^3 b}{(1-\nu^2)}\cdot\frac{\left[\frac{K(1-\nu)(a^2 - b^2)}{2a^2} - (1+\nu)\log\frac{b}{a}\right]}{\left[\frac{1}{1+\nu} - \log\frac{b}{a} - \frac{K}{2} - \frac{b^2 K}{2a^2}\left(\frac{1-\nu}{1+\nu}\right)\right]}. \quad . \quad . \quad . \quad (13)$$

This expression gives the moment of inertia of the reinforcement for any particular value of K; furthermore, because $0 < t d^3 < \infty$, it follows that

$$\left(\frac{1+\nu}{1-\nu}\right)\frac{2a^2\log\frac{b}{a}}{(a^2 - b^2)} < K < \frac{\left[\frac{1}{1+\nu} - \log\frac{b}{a}\right]}{\frac{1}{2}\left[1 - \frac{b^2}{a^2}\left(\frac{1-\nu}{1+\nu}\right)\right]}. \quad . \quad . \quad . \quad (14)$$

From equations (12) and (13) it is seen that the moment of inertia of the reinforcement and the moment M are fixed for any particular value of the parameter K. The maximum bending stress in the reinforcement (that is, $f_r = \frac{M b d}{2I}$) therefore increases linearly with d while the cross-sectional area of the reinforcement (that is, $td = \frac{12 I^2}{t d^2}$) decreases with d. It follows that for any given value of K the weight of the structure is a minimum when the maximum stress in the reinforcement and maximum stress in the plate are both equal to the maximum permissible stress for the material. The maximum stress in the plate is given by $f_{max.} = \frac{6 M_{max.}}{h^2}$ where $M_{max.}$ is the maximum moment in the plate.

From equations (6), (7) and (12) the following expression is obtained for the radial moment in the plate

$$M_r = \left\{-\frac{P(1+\nu)}{4\pi}\log\frac{r}{a} - \frac{P b^2 \log\frac{b}{a}}{4\pi(a^2 - b^2)}\left(1 - \frac{a^2}{r^2}\right) - \frac{M b^2}{(a^2 - b^2)}\left(1 - \frac{a^2}{r^2}\right)\right\}. \quad . \quad . \quad . \quad (15)$$

The tangential moment in the plate is given by

$$M_t = -D\left(\frac{\nu d^2 w}{dr^2} + \frac{1}{r}\frac{dw}{dr}\right). \quad (16)$$

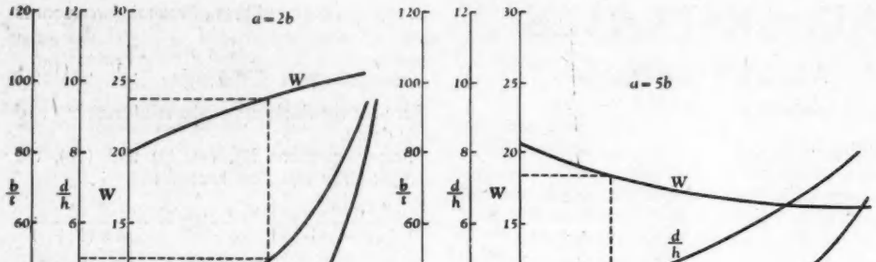


Fig. 3 The percentage saving in weight, W, is shown in terms of non-dimensional parameters related to the dimensions of the plate and the reinforcement. The two sets of graphs show how these relationships are modified when the ratio of plate diameter, a, to hole diameter, b, is increased from 2 to 5.

This becomes, after substituting for w,

$$M_t = \left\{ -\frac{P(1+\nu)}{4\pi} \log \frac{r}{a} + \frac{P(1-\nu)}{4\pi} - \frac{K(1-\nu) P b^2}{8\pi a^2}\left(1 + \frac{a^2}{r^2}\right)\right\}. \quad . \quad (17)$$

From equations (15) and (17) it is found that for $K < 1$ the maximum moment in the plate occurs at $r = b$ and acts in a tangential direction. Similarly, for $K > 1$ the maximum moment occurs at $r = b$ and acts in a tangential direction.

Equating the maximum stress in the reinforcement to the maximum stress in the plate gives

$$\frac{6 M b}{t d^2} = \frac{6 M_{max.}}{h^2}, \quad . \quad (18)$$

where $M_{max.}$ is obtained from equation (15) when $K > 1$ by putting $r = b$, and $M_{max.}$ from equation (17) when $K < 1$ by putting $r = b$. Substituting for $M_{max.}$ in equation (18), it is found that

$$td^2 = \frac{b h^2 \left[\frac{K(1-\nu)(a^2-b^2)}{2a^2} - (1+\nu)\log\frac{b}{a}\right]}{\left[\frac{K(1-\nu)(a^2-b^2)}{2a^2} - (1+\nu)\log\frac{b}{a} + (1-\nu)(1-K)Q\right]}, \quad . \quad . \quad . \quad (19)$$

where $Q = 1$ for $K < 1$ and $Q = 0$ for $K > 1$. Equations (13) and (19) determine the cross-sectional dimensions of the reinforcement which makes the weight of the structure a minimum for any arbitrary value of K.

From equations (15) or (17) the following expression is obtained for the maximum moment in the plate

$$M_{max.} = \left\{ \frac{K(1-\nu) P (a^2 - b^2)}{8\pi a^2} - \frac{P(1+\nu)}{4\pi} \log \frac{b}{a} + \frac{P(1-\nu)(1-K) Q}{4\pi}\right\}. \quad . \quad . \quad . \quad (20)$$

Thus, if the maximum stress permissible in the plate is f, the necessary thickness of the plate is

$$h = \sqrt{\frac{6}{f}\left[\frac{K(1-\nu) P (a^2 - b^2)}{8\pi a^2} - \frac{P(1+\nu)}{4\pi} \log \frac{b}{a} + \frac{P(1-\nu)(1-K) Q}{4\pi}\right]}, \quad . \quad . \quad . \quad (21)$$

since

$$f = \frac{6 M_{max.}}{h^2}.$$

SAVING EFFECTED BY USE OF REINFORCEMENT

For the same maximum stress the necessary thickness of a similarly loaded unreinforced plate is

$$h_u = \sqrt{K_u \frac{P}{f}}, \quad . \quad . \quad (22)$$

where K_u is a constant depending on the ratio $\frac{a}{b}$. Values of K_u corresponding to different values of $\frac{a}{b}$ are given in, for example, Timoshenko[1] page 68. Equations (13), (19) and (21) give the volume of the unreinforced plate in terms of the parameter K while equation (22) determines the volume of a similarly loaded unreinforced plate having the same maximum stress. The percentage weight of material saved by using the reinforcement is therefore a function of the parameter K and is given by the expression

$$W = \left(\frac{V_u - V}{V_u}\right) 100. \quad . \quad (23)$$

where V is the volume of the reinforced plate and V_u the volume of the unreinforced plate with the same maximum stress. The problem, therefore, reduces to choosing a value for the parameter K which makes W as large as possible consistent with the conditions that the dimensions of the reinforcement are within limits which are considered practicable. This choice can readily be made with the aid of a graph in which W, $\frac{d}{h}$ and $\frac{b}{t}$ are all plotted against the base K.

As an example, consider the cases in which $\nu = 0{\cdot}3$ and $\frac{a}{b} = 2$ and $\frac{a}{b} = 5$ respectively. Suppose, for design purposes, the upper limit of $\frac{d}{h}$ is fixed arbitrarily as 5 which is quite reasonable for a ring reinforcing the skin of an aircraft. Also, to satisfy the assumption that the diameter of the hole is large compared with the width of the reinforcement, let the minimum value of $\frac{b}{t}$ be fixed at 20. The graphs on the left and right in Fig. 3 show the variation of W, $\frac{d}{h}$ and $\frac{b}{t}$ with respect to K for $\frac{a}{b} = 2$ and $\frac{a}{b} = 5$, respectively. For $\frac{a}{b} = 2$ it can be seen that W increases as K increases so that it pays to make $\frac{d}{h}$ as large as possible. In this particular example $\frac{d}{h}$ must not be greater than 5 so that the maximum amount of material that can be saved by reinforcing the hole is 24 per cent.

For $\frac{a}{b} = 5$, the right-hand graph shows that W decreases as K increases so that the amount of material saved is a maximum when $\frac{b}{t}$ is as small as possible. In this example $\frac{b}{t}$ must not be less than 20 so that the maximum weight of material that can be saved by reinforcing the hole is 17·5 per cent.

REFERENCE

[1] *Theory of Plates and Shells*, by S. Timoshenko. McGraw-Hill Book Company.

ATOMIC ENERGY INFORMATION

RELEASES FOR NON-MILITARY PURPOSES

As a result of recommendations made by the Sixth Tripartite Declassification Conference, which was held at Chalk River, Canada, in April, 1953, certain amendments were made to the code which is used to decide what atomic energy data may be published and what must remain secret.

It was agreed that while information of critical importance for the design or operation of reactors for plutonium production for military purposes must still be kept secret, information required for the study of the economics of power reactors should, as far as possible, be released. A detailed examination was therefore made as to how such principles could be applied to natural uranium and slightly enriched uranium reactors and a list was made showing the kind of information which could be safely released.

Up to the present, all work in production establishments, such as those at Windscale and Capenhurst, has been treated as classified. Many of the less important details and processes will now, however, be released, while maintaining secret the production technology of substances of critical importance. It has also been agreed that some of the older production processes relating to heavy water and graphite and to the reduction of uranium compounds to metal can be declassified.

In the field of nuclear physics all information on neutron cross sections of carbon and graphite, as well as on the spontaneous fission rate of plutonium 240, has been declassified. Values for the thermal neutron cross sections of uranium 235, uranium 238, natural uranium and plutonium 239, were previously released and it has now been agreed that these cross-sections may be published together with experimental details of the method of measurement.

Much of the basic chemistry of plutonium has already been declassified and it has now been agreed that some of the physical properties relating to the metallurgy of pure plutonium can be treated in the same way. Other releases include basic chemical studies involving the use of ion-exchange resins for all elements except plutonium and basic studies on the chemical kinetics of fluoride corrosion.

TRENDS IN AIR CONDITIONING

SAVING COST AND SPACE BY PRE-FABRICATION

By G. R. Winch, A.M.I.H.V.E., A.M.INST.F.*

Since the immediate post-war years there have been several changes in the application of air-conditioning equipment to buildings both at home and overseas, particularly in the United States.

Formerly, a high proportion of air-conditioning installations in large buildings were of the "built-up" central type; these consisted of viscous or dry fabric filters, finned-tube heater batteries, spray-type air washers, reciprocating compressors, and centrifugal fans developing a total head of between 1 in. and 2 in. water gauge and delivering the conditioned air into rectangular galvanised-steel ductwork in which the maximum air velocity rarely exceeded 1,800 ft. per min.

Owing to the increased cost of building to-day, space within a building is at a premium and modern plants must be more compact while retaining the features of operating efficiency and accessibility for maintenance. The necessity for reducing costs has encouraged the production of the simpler type of system, which, if carefully designed and installed, gives good results. The growing practice of "packaging" or of factory assembly of the components, tends to lower overall costs due to the reduction in site labour. Examples of equipment made in the United Kingdom and in the United States are illustrated on this and the following page.

There is a general tendency in all but industrial air-conditioning systems to replace the spray washer by direct expansion or by chilled-water finned-tube cooler batteries for cooling and de-humidifying purposes as they require less space, less maintenance and are initially cheaper. Their weight and operating noise level are also lower. When necessary, humidification is then carried out by low-pressure water sprays or by steam jets. Where washers have to be used, the capillary air washer may be preferred to a spray washer, despite its higher initial cost, because of its higher efficiency, lower pumping costs and overall compactness.

HIGH-VELOCITY DISTRIBUTION SYSTEMS

The difficulty in accommodating large ducts in modern reinforced and prestressed-concrete buildings has led to the development of distribution of high-velocity air, in which the conditioned air is distributed by circular galvanised-steel ductwork at velocities up to 5,000 ft. per min., necessitating fan total heads of up to 6 in. water gauge. While this arrangement provides a valuable reduction in duct size for a given capacity, special measures need to be taken to deal with the increase in fan and duct noise. Also, the high static pressure in the ducts must normally be reduced at the air outlets, to provide satisfactory air distribution within the room. In order to reduce air quantities further, the temperature difference between the conditioned air and the room is increased from the usual figure of 15 deg. F. to about 30 deg. F. This, however, is too large to avoid draughts and it is necessary to reduce the temperature difference at the outlets to around 15 deg. F. by mixing with room air. This admixture is also necessary where the general room-air motion may be insufficient with smaller air quantities.

At present there are two main methods of meeting these requirements. In the first, the normal type of wall grille or ceiling diffuser is modified by the attachment of a plenum chamber incorporating a regulating damper, a sound absorber and an induction device to draw room air into the chamber. Thus the high velocity and noisy flow of conditioned air which enters the plenum box with a large temperature difference, is admitted into the room at a velocity, sound level and temperature comparable to that occurring in a conventional system. Two examples of wall or ceiling units are shown in Figs. 1 and 2 on this page.

The second method is to feed the air into a free-standing or recessed cabinet unit such as that illustrated in Fig. 3, below. This cabinet, which is usually placed beneath windows, performs the same function as the plenum box in reducing noise and pressure to desirable levels and in providing a mixture of conditioned and room air at a suitable temperature. The use of cabinets permits a further reduction in duct size as a heating or cooling battery supplied with hot or chilled water may be included, so that the sensible-heat load of the room may be met by the induction of room air over the battery before mixing with conditioned air. The conditioned or primary air volume is thereby reduced to that necessary for ventilation purposes, the temperature and moisture content being adjusted at the central plant to deal with the latent-heat load, in order to maintain the relative humidity within desired limits. A further advantage is that re-circulation ductwork is usually unnecessary and zoning is made easy in the case of multi-room buildings, such as hotels and offices, which have varying exposure to solar radiation, because the room temperature may be adjusted by the occupants by varying the flow of water through the battery. Although the relative humidity in the room will change when the sensible-heat load is altered, it does not seem difficult to keep this within acceptable limits by careful design.

Fig. 1 Ceiling air-distributing unit for high-velocity system. The air flow pattern may be altered by adjusting the setting of the cones. (Anemostat Corporation, U.S.A.)

ROOM-CONDITIONING UNITS

As an alternative to the high-velocity system, the difficulties associated with large ducts have been avoided elsewhere by using room-conditioning units consisting of a filter, a heating and/or cooling battery, a centrifugal fan or fans, and a damper for adjusting the proportions of fresh and re-circulated air, all enclosed in a metal cabinet. These units are supplied with chilled or hot water as necessary from a central plant room and are usually placed beneath windows on an external wall, since a fresh-air connection to the unit is required. A drain-pipe is necessary to carry away moisture condensed when de-humidifying. In cases where the provision of

* Messrs. Kennedy and Donkin.

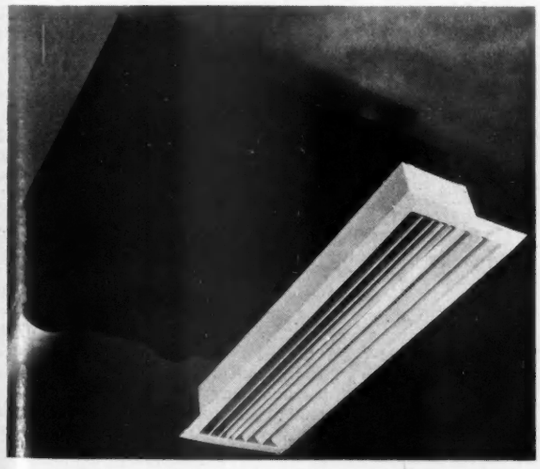


Fig. 2 Wall or ceiling unit for high-velocity system. The plenum box is normally concealed by the wall or ceiling. (Anemostat Corporation, U.S.A.)

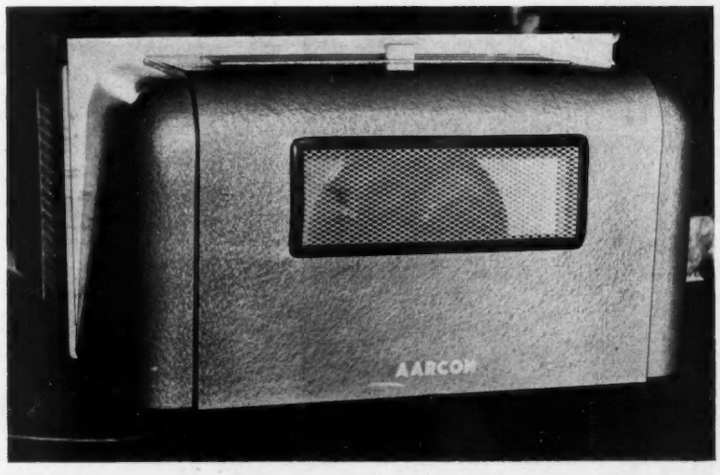


Fig. 3 Small room air conditioner with hermetically sealed compressor. The conditioner is easily mounted in the lower part of most windows and is plugged into an electric power point. (Continental Components Ltd.)

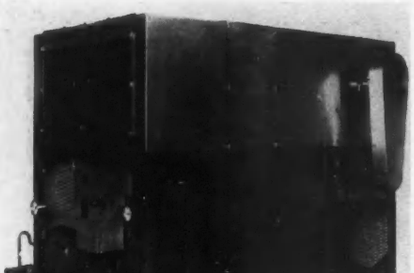


Fig. 4 Complete central air-conditioning unit of 10-tons capacity. The air filter, cooler and fan are mounted over the compressor, motor and condenser. (Alfred Porter & Co.)

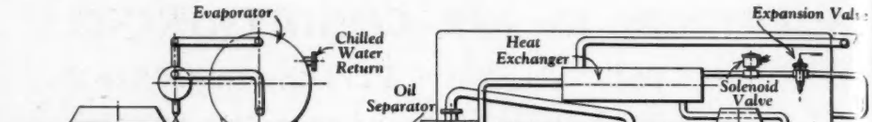


Fig. 5 Layout of self-contained water-chilling unit with belt-driven reciprocating compressor. (Alfred Porter & Co.)

many holes in external walls is undesirable, ventilation air may be supplied by a small low-velocity ductwork system. This air input may be conditioned at a small central plant to control the relative humidity of the room if the latent-heat load is large.

PACKAGED AIR-CONDITIONING UNITS

In common with the post-war trend for prefabrication, there is now available a wide range of " packaged " or standardised air conditioning units having capacities of up to 60 tons.* Such units contain all of the components of a complete central plant assembled within a steel angle and sheet casing. An example of a small machine of this type, of only 10-tons capacity, is shown in Fig. 4 on this page. The only connections which have to be made at the site are to the air ducts, the water connections to the refrigerant condenser, the steam or water supply to the heating coil (if fitted), the drain from the cooling battery and the electrical connections. The use of these units enables savings to be made in the space occupied, and in the installation time and cost.

Both reciprocating and centrifugal refrigerating plants are available as self-contained units, and two large examples of such plant made in the United States are illustrated in Fig. 6 and 7, below. Each consists of a compressor and motor, condenser, evaporator and all piping, wiring and safety controls, complete with a charge of refrigerant. By making the chilled water, cooling water and electrical connections the plant is ready for operation. Refrigeration plants operating on the absorption cycle are also available as complete units requiring only electric, steam or gas, chilled water and cooling water connections to be made at site. The layout for a self-contained water-chilling unit is given in Fig. 5, above.

There is a tendency for the belt-driven medium-speed reciprocating compressor to be displaced by the direct-connected multi-cylinder compressor running at standard motor speed. This results in a more compact compressor for a given output and the larger number of cylinders and increased speed simplify vibration isolation.

The non-toxic Freon refrigerants, or their Arcton equivalents, are extensively used for air conditioning, and for all practical purposes have replaced ammonia, methyl chloride and sulphur dioxide in this field.

REDUCING MAINTENANCE WORK

A noteworthy improvement in the small independent room conditioners is the substitution of the hermetically-sealed refrigeration compressor/motor combination for the normal type of compressor with shaft seal and belt drive. This should reduce the amount of skilled maintenance required, and the direct-connected compressor rotating at motor speed is more compact for a given duty and makes vibration and noise isolation more simple.

During the last two or three years electric automatic controls of the modulating or proportioning type have again been available in Britain, enabling electric controls to be used in applications where pneumatic or hydraulic controls had to be used previously. Though pneumatic controls are usually selected for industrial work, electric controls have advantages when used in comfort air-conditioning systems since they require less maintenance and are usually cheaper; " comfort air-conditioning systems " denotes systems installed in restaurants, cinemas, large departmental stores and other large buildings where the comfort of the occupants is of paramount importance.

Another development of interest is the production in the United States of backward-curved centrifugal fans with aerofoil-section blades for air conditioning. The non-overloading feature and the steep pressure curve of backward-curved fans is retained, with the advantages of an increase in efficiency of the order of 10 per cent., and a noise level reduction of about 3 decibels. This type of fan seems to be well suited to the high-velocity air-distribution systems mentioned previously.

* A refrigerating capacity of 1 ton is equivalent to an extraction of 12,000 B.Th.U. per hr., which is the rate of heat extraction required to produce 2,000 lb. of ice per day from water at 32 deg. F.

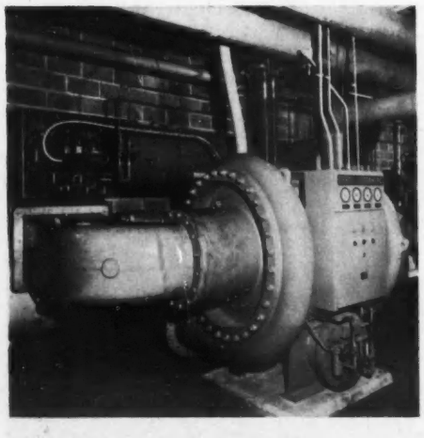


Fig. 6 Self-contained water-chilling unit with two-stage hermetically-sealed centrifugal compressor and motor, condenser, evaporator, oil tank and control panel. (Trane Co., U.S.A.)

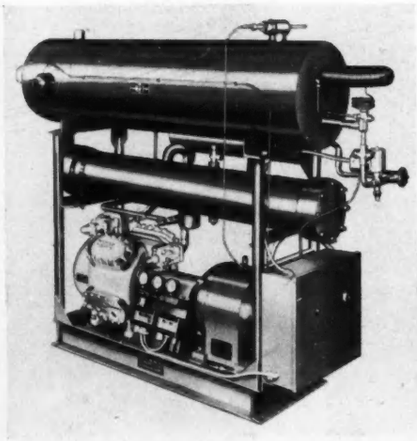


Fig. 7 Self-contained water-chilling unit with direct coupled reciprocating compressor, condenser, evaporator and controls. The unit is piped, wired and charged with refrigerant. (Trane Co., U.S.A.)

★ ★ ★

GEAR RATING COMPUTER

Power, Pitch and Stresses for Helical and Spur Gears

To calculate the permissible horse-power ratings for spur or helical gears on a wear or strength basis, and to ascertain the necessary pitch, face-width or material of a gear, given the horse-power it must transmit, Fearns and Mear, 22 Stanley-road, Lindley, Huddersfield, have introduced a computer, which, the makers claim, enables calculations – hitherto requiring perhaps more than half an hour – to be performed in a few seconds. Similar in form to a circular slide rule, the computer is calibrated in accordance with the formulae and charts given in B.S. 436 : 1940 (Machine cut gears: helical and straight spur).

In order to obtain the horse-power rating for a pair of gears, it is necessary first to determine their zone or strength factors from the reverse side of the computer. This requires one setting of the cursor. The scales on the front of the computer are set using the value thus found and other given conditions such as number of teeth, pitch or rotational speed. The maximum horse-power which the gears may be permitted to transmit for every inch of face, is then read directly from the computer scale.

The scales of the computer are engraved on white ivorine and Perspex and are marked in three colours to enhance clarity of reading. The main disc is 7¾ in. in diameter and the length of the horse-power scale is 16 in. The range of the computer covers gears with from 10 to 400 teeth, diametral pitches between 1 and 30 and speeds extending from 0·01 r.p.m. to 25,000 r.p.m. Horse-powers from 0·001 to 75,000 may be estimated, and, on scales giving the limiting bending and surface stresses, are also noted the corresponding materials, from which the gears might suitably be cut.

A SQUAT LOAD-MEASURING GAUGE

STATIC OR TRANSIENT LOADS OF UNCERTAIN ECCENTRICITY ACCURATELY DETERMINED

By C. W. Newberry, B.SC.(ENG.), A.M.I.MECH.E.

This article describes a gauge developed by the Building Research Station for measuring compressive loads, particularly loads such as those exerted by jacks where the axis of loading is not precisely known and where the stability of the loading system must not be appreciably lessened by the measuring device. The gauge may be used for measuring either static or dynamic loading. It has been provisionally patented under United Kingdom Patent Application No. 30986/52.

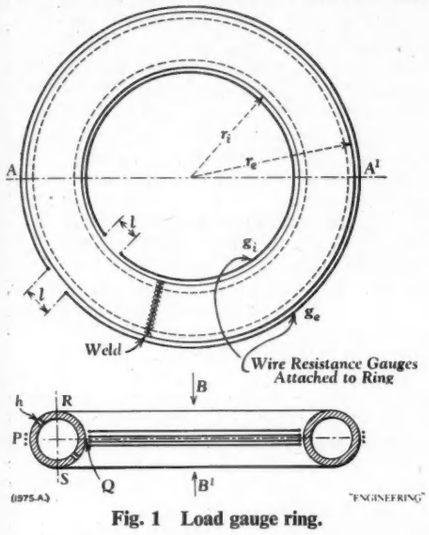


Fig. 1 Load gauge ring.

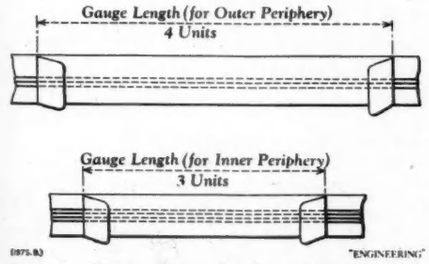


Fig. 2 Construction of wire resistance strain gauges.

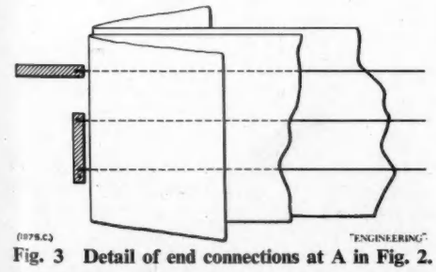


Fig. 3 Detail of end connections at A in Fig. 2.

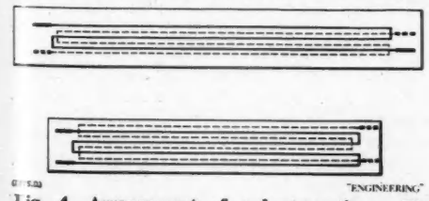


Fig. 4 Arrangement of end connections. The solid lines show the arrangement for one strain gauge. The dotted lines show the additional windings added to complete the four-arm strain-gauge bridge.

DIFFICULTIES IN MEASURING JACK LOADS

The work of the Building Research Station frequently involves the measurement of compressive loads in conditions where there is little room to instal a load-measuring instrument, and where it is imperative that the inclusion of any such instrument does not appreciably lessen the stability of the compressive system. Such applications occur, for instance, in the measurement of strut loads and of the forces exerted by jacks.

Jacking as a means of applying test loads introduces further difficulties in that the axis of loading is seldom precisely known ; and the load-measuring device should therefore be able to accept eccentric loads without a serious loss of accuracy.

Proving rings are the most accurate means available for measuring test loads, but, unless provided with suitable lateral restraints, they introduce a considerable degree of instability in the loading system. Alternative devices, having less height in the direction of the load axis, are available, but in general they are not sufficiently accurate under eccentric loading unless they incorporate some form of ball seating, and this leads again to a degree of instability. The work described in this article was therefore undertaken to provide a suitable means of measuring compressive loads in the type of applications mentioned.

The original conception of this load gauge was that it should be essentially a short cylinder that could be fastened temporarily to the ram of the jack with which it was to be used ; and that it would measure the applied load in terms of the strain in the cylinder as indicated by a series of wire resistance strain gauges. Several experimental models were made in this form. As a result of this work, however, it was concluded that the length of the cylinder, and hence the thickness of the gauge in the direction of loading, could not be made small enough to satisfy the requirements as to the physical dimensions of the gauge and at the same time give adequate sensitivity and uniformity of response under varying eccentricity of loading. Some of the cylinders tested were hollow with comparatively thin walls, consisting, in fact, of short lengths of steam pipe about 1 in. long, and it was but a short, though fundamental, step from these to the form which proved satisfactory and which has been adopted and developed.

TOROIDAL GAUGE LOADED NORMALLY TO PLANE OF RING

In its present form the load gauge consists of a length of steel tubing bent into a circle and welded where the two ends come together to form a toroid ring, as indicated in Fig. 1. If this ring is laid on the platen of a press and squeezed in a direction normal to the plane of the ring, i.e., direction BB′ in Fig. 1, the cross-section of the tube of which the ring is made will be deformed, suffering a contraction in the direction RS and an extension in the direction PQ.

Thus, the inner periphery of the ring will be shortened and the outer periphery lengthened ;

Fig. 5 Complete load gauge mounted on a jack ram.

and these changes will be approximately proportional to the load applied to the ring.

Measurement of the changes in length of the inner and outer peripheries gives complete integration of the load all round the ring and hence an indication of the total load on the ring regardless of its distribution. It is for this reason that this form of load gauge is not adversely affected by considerable eccentricity of the load system with respect to the gauge. Furthermore, since the strain in the inner periphery is compressive while that in the outer periphery is tensile, strain gauges can be fixed to both surfaces and so connected as to provide a system which is self-compensating against the effects of changes in ambient temperature.

Wire resistance strain gauges of suitable dimensions were therefore fixed round the inner and outer peripheries of the ring, as shown in Fig. 1. So that both gauges should have the same resistance, the number of strands of wire in a gauge was arranged to be in inverse ratio to the length of the gauge and so was related to the proportions of the ring. In the ideal case $\frac{T_e}{T_i} = \frac{r_i}{r_e}$ where T_e and T_i are, respectively, the number of strands in the gauges fitted to the outer and inner peripheries, and r_e and r_i are the radii of the outer and inner peripheries. In this ideal case the length of the gauge g_e would equal exactly that of the outer periphery and the length of the gauge g_i would equal that of the inner periphery. The former might have been realised by winding the strain gauge directly on to the ring, but winding direct on to the inner periphery was not considered practicable with the methods available. The gauges were, therefore, made separately and subsequently attached to the ring. In practice it was necessary to leave a small gap l between the two ends of the gauge in order to provide room for anchoring the gauge ends and connections, and in consequence $\frac{T_e}{T_i} = \frac{2\pi r_i - l}{2\pi r_e - l}$.

T_e and T_i had to be whole numbers in order that each gauge should integrate the deformations all along its length; and to suit the method of construction of the gauges, the number of strands had to be kept as small as possible. On the other hand, the ratio $\frac{r_i}{r_e}$ could not be less than about $\frac{3}{4}$ because of the difficulty of hand-bending the steel tube into rings of greater curvature. The values $T_e = 3$ and $T_i = 4$ were

therefore selected as offering the most suitable number of strands in the gauges.

BRIDGE CIRCUIT MOUNTED ON RING

At this stage of the description it may not be apparent why any insistence was placed on matching the gauge resistances, thereby imposing a restriction on the proportions of the ring. The simple arrangement of two gauges forming two arms of a bridge circuit does not necessitate an equal-arm bridge. But while the early development of the gauge was restricted to this simple arrangement, it was always intended, once the system had been proved successful and the techniques of gauge manufacture and bonding had been mastered, to mount two gauges around the inner periphery and two around the outer periphery, thereby fixing the whole bridge circuit on the ring. Such an arrangement increases the load gauge sensitivity and prevents possible variations of contact resistance in the bridge network, but it does necessitate an equal-arm bridge and was the reason for the design considerations already described.

The prototype load gauges have been hand-made with limited resources which have, to some extent, governed the design. For this reason the following description of the constructional details must be regarded as illustrating a stage in the development of the gauge rather than defining the optimum proportions to be adopted when more advanced techniques of manufacture are available.

To suit the application to jack loading it was considered that the load gauge should have a bearing surface about 4 or 5 in. diameter; whence, if the mean diameter $(r_i + r_e) = 4\frac{1}{2}$ in. and $\frac{r_i}{r_e} = \frac{3}{4}$, then $r_e - r_i$ must be approximately $\frac{5}{8}$ in. Tube of $\frac{5}{8}$ in. diameter was therefore selected and appeared to be a suitable size on which to mount the wire resistance gauges, whose width when made up was expected to be about $\frac{1}{10}$ in. As the calculation of stresses in the ring appeared to be a difficult and lengthy process, three cold-drawn steel tubes of different wall thicknesses were selected with a view to the experimental determination of their load capacity. These tubes were of 20, 16 and 12 s.w.g. After annealing, they were bent by hand round a mandrel to form rings having an internal diameter of 3·95 in. and an external diameter of 5·2 in., this size allowing about 0·6 in. for the gap l (Fig. 1) which was thought to be necessary for fixing the connections to the strain gauges. The rings were made as nearly plane as was practicable and the ends welded to give continuity. A small hole was drilled obliquely through the ring as at h (Fig. 1) to provide access for the leads to the gauge on the inner periphery.

FORMING THE STRAIN GAUGES

Nichrome wire was selected for the wire resistance strain gauges since it gave a suitable gauge resistance with the length and size of wire used. If finer wire could have been handled successfully it would have been preferable to use Eureka.

To overcome the difficulties of making a continuous winding to the required dimensions, the wire resistance strain gauges were formed as follows. A cylindrical wooden former was made, with a circumference greater than the length of the longest gauge to be made, and mounted in a coil winder so as to rotate about the axis of the cylinder. A strip of thin paper was laid round the former and coated with a thin layer of sticky thermo-setting cement (Bakelite Ltd. G.11091). Three or four turns of Nichrome wire, according to the number of strands required in the gauge, were wound on to the paper and, after a further coating of resin, were covered with another strip of paper. The assembly was then placed in an oven and the temperature raised, slowly, to avoid the formation of bubbles in the resin, to 115 deg. C., at which it was held for three hours. The wire used was 0·0032 in. in diameter (44 s.w.g.), giving a resistance of about 230 ohms per gauge. It was spaced at 0·020 in. pitch for gauges with four strands and at 0·030 in. for gauges with three strands, making an overall width of approximately 0·06 in. for the windings of each gauge.

The hoops of wire thus formed were cut through at a point on the periphery close to the join in the paper base and laid out on a bench. The upper paper was marked at each end of the required gauge length and turned back from the wire to these marks (Fig. 2). The lower paper was turned away from the wire to the corresponding points and the wires were cut off short leaving just sufficient wire protruding to make a spot weld to the connections, as indicated in Fig. 3. The connections, which were made of hot-tinned Nichrome strip, were subsequently enclosed by restoring the turned-back ends of paper and cementing them together. The complete arrangement of end connections is shown in Fig. 4, which also includes, as dotted lines, the additional windings added to make the complete four-arm bridge mentioned earlier. These windings were made on top of the second layer of paper, which thus served to insulate them from the first winding, and were themselves covered with a further strip of paper. In this case the whole assembly was cured in one operation as before and the end connections made by an extension of the process already described.

RESISTANCE GAUGES BONDED TO LOAD RING

The method of mounting the resistance gauges on the load ring was determined by a process of trial and error, and, though it will not serve a useful purpose to describe the whole of the methods tried, there is one lesson to be learned. The earliest gauges were made and bonded to the ring with cellulose acetate cement, which, though it gives good adhesion in many situations, was found to be unsuitable for bonding the gauge on the inner periphery. This was because the cement-bonded gauge shrank on drying and tended to tension itself along short chords rather than lie around the arc of the periphery.

The technique adopted was to coat the ring, after degreasing, with a thin layer of Bakelite resin diluted with alcohol to a suitable consistency. The gauges were then applied to the ring, one to the inner and one to the outer periphery, starting close to the hole which was to carry the leads. Tape was used to bind the gauges tightly against the ring, neat resin being applied to the gauges as the windings progressed. The whole was then cured in an oven for three hours at 115 deg. C. A ring in this condition is shown in Fig. 6. Originally the tape covering was left in position, and the end-connection tags were exposed by filing carefully through the covering, but in later models the tape was stripped off to reduce hysteresis The load gauges were mounted between cover plates before being put into use. (Figs. 5 and 7.)

TESTS OF LOAD GAUGE

Load gauges constructed in accordance with the methods described in the preceding sections were tested in compression in a single-lever testing machine. The load was applied through a ball-seated platen so that the axis of loading with respect to the axis of the load gauge was known. In all cases the load gauge was completely covered by the platen.

The electrical leads from the gauge under test were connected to a Baldwin strain indicator, this being the most convenient instrument available for the purpose. The meter readings are arbitrary units. They do not give directly a measure of strain since the gauge factor of the resistance gauges was not determined precisely, but was assumed for the purpose of setting the meter to be 2·0; and the fact that there were four active gauges in the bridge network resulted in a meter reading approximately four times greater than the strain around the periphery of the ring.

A load gauge having a ring approximately $4\frac{1}{2}$ in. in mean diameter, made from $\frac{5}{8}$-in. steel tube of wall thickness 20 s.w.g., and carrying four active strain gauges, was loaded axially by increments of 0·1 ton; meter readings were noted for each load. The gauge gave a straight-line calibration up to a load of 3·8 tons. The sensitivity was 2,050 meter-units per ton. Loading was continued up to 4·8 tons, by which time noticeable permanent strain had been produced in the gauge, with a consequent shift of zero on the meter. As a result of this test the working range for a gauge of this size was tentatively fixed at 1·5 tons.

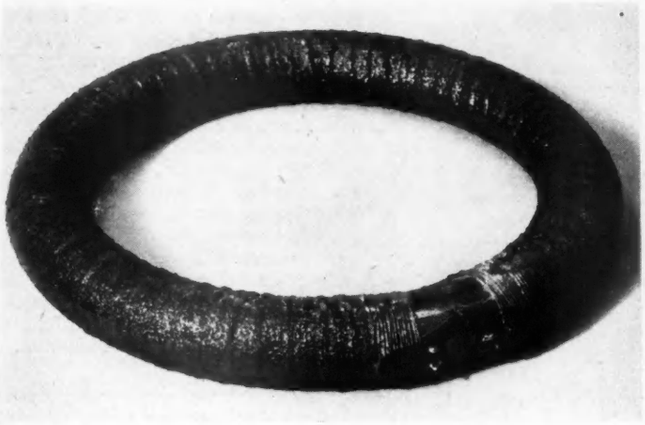
Separate tests were also made to determine the output of the four individual strain gauges; and it was noted that, within the elastic range of the load gauge, the two outer resistance gauges had sensitivites identical to those of the two inner gauges. The outer resistance gauges, however, contributed 54 per cent. of the total load-gauge sensitivity while the gauges on the inner periphery contributed 46 per cent.

Owing to the permanent strain in the first gauge, another similar gauge was made up for further testing and loads were kept within the assumed working range. A series of loading tests was carried out with axial and with eccentric loads. The maximum load was progressively restricted with increasing eccentricity of load axis in order to avoid local overloading of the ring. The results are given in Table I.

TABLE I. *Load Tests on $4\frac{1}{2}$-in. dia. Ring of $\frac{5}{8}$-in. o.d. 20-s.w.g. Steel Tube*

Load, Tons	Meter Increments (Baldwin Strain Indicator)					
	Eccentricity of Loading (e)					
	Axial, $\frac{e}{r} = 0$	$\frac{1}{2}$-in., $\frac{e}{r} = 0{\cdot}2$	1-in., $\frac{e}{r} = 0{\cdot}45$	$1\frac{1}{2}$-in., $\frac{e}{r} = 0{\cdot}65$	2-in. $\frac{e}{r} = 0{\cdot}9$	
0	0	0	0	0	0	
0·1	218	217	216	214	218	
0·2	430	422	428	421	422	
0·3	643	629	633	637	634	
0·4	842	838	847	841	839	
0·5	1,047	1,049	1,052	1,049	1,048	
0·6	1,260	1,252	1,260	1,259	—	
0·7	1,463	1,458	1,465	1,457	—	
0·8	1,669	1,662	1,670	—	—	
0·9	1,876	1,872	1,870	—	—	
1·0	2,069	2,069	2,070	—	—	
1·1	2,284	—	—	—	—	
1·2	2,487	—	—	—	—	
1·3	2,690	—	—	—	—	
1·4	2,888	—	—	—	—	
1·5	3,086	—	—	—	—	

It will be noticed that the sensitivity (2,070 meter-units per ton) is approximately the same as for the previous ring. Differences in hand manufacture of the ring and gauges could easily account for the small difference in sensitivity. Similarly, slight imperfections in forming the ring (it was not perfectly flat) are probably the reason for the initial load increments causing a meter increment slightly greater than the average for the test. Apart from the initial readings, departures from linearity of calibration are entirely within the limits of accuracy of operation of the testing machine and the Baldwin indicator. It is apparent that the eccentricity of loading causes no significant error in the measurement of the load. It is to be noted, however, that this result was obtained on an optimum diameter which minimised the effects of the gap where the leads were connected. Measurements on random



The load gauge described in this article uses a tubular ring, to the outer and inner peripheries of which wire resistance strain gauges are bonded and then bound with tape, as shown in Fig. 6. The load to be measured is applied in a direction perpendicular to the plane of the ring through the cover plates shown in Fig. 7.

Fig. 6

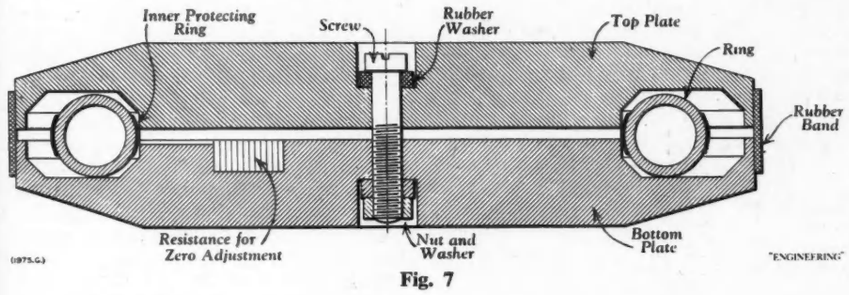


Fig. 7

diameters gave errors under extreme eccentric loading of up to ± 3 per cent. on rings having a gap of 0·6 in. between the gauges.

THIN-WALLED TUBE GIVES GREATEST SENSITIVITY

Gauges having the same external dimensions but made of tubes of different wall thicknesses were tested to determine the influence of wall thickness on the load capacity and sensitivity; also a gauge made to the same proportions but utilising ¾-in. diameter tube. The results are given in Table II.

TABLE II. *Load Tests on Gauges of Different Wall Thicknesses and Tube Diameters*

Mean Diameter of Ring, in.	Tube Diameter, in.	Tube Wall Thickness, s.w.g.	Working Capacity, Tons	Sensitivity (Units on Baldwin Strain Indicator, per ton)
4½	⅜	20	1½	2,050
4½	½	16	3½	500
4½	⅝	12	10	110
5½	½	14	4	310

It will be seen that the efficiency of the load gauge, measured in terms of meter reading at full load, is greatest for thin-walled tube.

The tests carried out so far have established that the form of load gauge described can be an efficient instrument for the measurement of compressive loads. The sensitivity of the most efficient of the sizes tested is about 3,000 Baldwin strain indicator units for full working load. This corresponds to an output of approximately 1·5 millivolts per volt at full working load with a mild-steel tube. This figure could be doubled, and possibly trebled, by the use of materials such as alloy steel or K Monel having a higher ratio of elastic limit to modulus of elasticity.

Present work has been restricted to the ring and tube proportions described in order to facilitate the hand manufacture of the strain gauges, but the indication that thin-walled tube is appreciably more efficient than thick-walled tube leads to the suggestion that different load ratings should be catered for by a variation of tube diameter rather than tube wall thickness, and this should be feasible given the design flexibility that would result from more advanced techniques of strain gauge manufacture.

The author acknowledges the great help given by Mr. D. W. Bryden-Smith in the development of the gauge. The article is published by permission of the Director of Building Research.

* * *

MERCURY SWITCHES FOR MECHANICAL HANDLING EQUIPMENT

The General Electric Company, Limited, Kingsway, London, W.C.2, have produced a weatherproof "rotation" switch for use with conveyors and other continuously-running mechanical equipment on which warning of a breakdown or partial stoppage is essential. It is arranged for attachment to the layshaft of the system and is made in two patterns either for breaking the circuit or for making it, if the shaft is either stopping or running too slowly.

Each pattern contains two mercury switches of either the delayed-break or delayed-make type. The alternating-current carrying capacity is 5 amperes at 250 volts and the direct-current carrying capacity is 1 ampere at the same voltage. The switches, which are carried in cradles so that they can swing independently against a light pressure, are moved by two Tufnol cams. The latter are mounted at opposite ends of a diameter on a stainless-steel shaft, which projects through a felt packing gland in the side of the aluminium-alloy containing box, so that it can be driven from a convenient take-off point on the machinery. The switches remain stationary in either the break or make position for from three to five seconds before they operate. This operation occurs at speeds between 25 and 50 r.p.m., which is the range of the average conveyor, layshaft or idler.

As an example of its application it may be mentioned that the break-circuit switch can be wired into a relay circuit controlling the motor of the preceding conveyor, so that it switches out that motor if its own conveyor stops or runs too slowly. By equipping a conveying system or other material handling plant with a series of such relays a "chain reaction" can be initiated and a build-up of material prevented. The last switch in such a series can also be arranged to give an audible or visual warning.

* * *

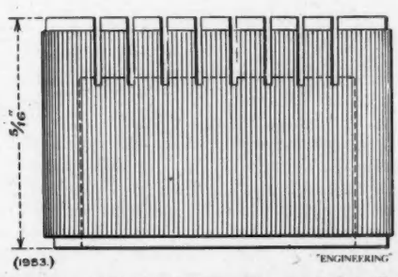
CORE-BOX VENTING

A New Vent Plug

The conventional means of venting the core-box used on a core-blowing machine is the brass vent plug. This is in the form of a cylinder, with one end open and the other made into a grid by milling a number of fine slots across it. The vent is a light driving fit in a hole drilled in the core-box wall, and the "head," or gridded end, can be made with sufficient depth to enable it to be shaped to suit the internal contour of the core-box if necessary. The brass vent has certain disadvantages. It has a faster rate of wear than the steel core-box in which it is fitted, the vent slots get clogged with sand particles, and there is a tendency for the sand to adhere to the face of the vent itself. The core-box has thus to be taken out of production from time to time for re-venting, and a certain amount of time is lost by the necessity for cleaning the slots and vent faces. In addition, adherence of sand to the vent faces makes it necessary for some of the cores to be repaired by hand.

Experiments in the U.S.A. with vents made of steel showed that, as would be expected, the life of the vent was increased considerably, and it was also found that slot-clogging and sand adherence were reduced to negligible proportions. As a result, steel vents have become widely used in America. Some foundries have claimed that because of the increased availability of the core-boxes, due to the fact that the vents last longer and need less cleaning, output has been increased by 25 per cent.

Steel vents are now available for the first time in this country. They are being produced in quantity by Temple Instruments, Limited, Sharrocks-street, Wolverhampton, who are also makers of the conventional brass vent. The Temple steel vent is made in a variety of diameters, ranging from ⅛ in. to 1¼ in., the overall depth in all cases being 5/16 in. They have a common wall thickness of approximately 0·040 in., and are finished with a fine straight knurl on the outside diameter. It is, therefore, only necessary to drill a hole of the nominal diameter in the wall of the core-box for fitting a vent. The standard slot in the head of the vent is 0·010 in. wide, the spacing between the slots being 0·040 in. or 0·050 in. according to the vent diameter. Two depths of head are available: 5/16 in., which is standard, and allows for shaping to suit the core box, and 5/32 in., which is suitable for use with a flat surface. The steel vents are interchangeable with the brass vents made by the same manufacturers.



Drawing of the steel core-box vent described above; it has a longer life than the usual brass vent, and reduces slot-clogging and sand adherence.

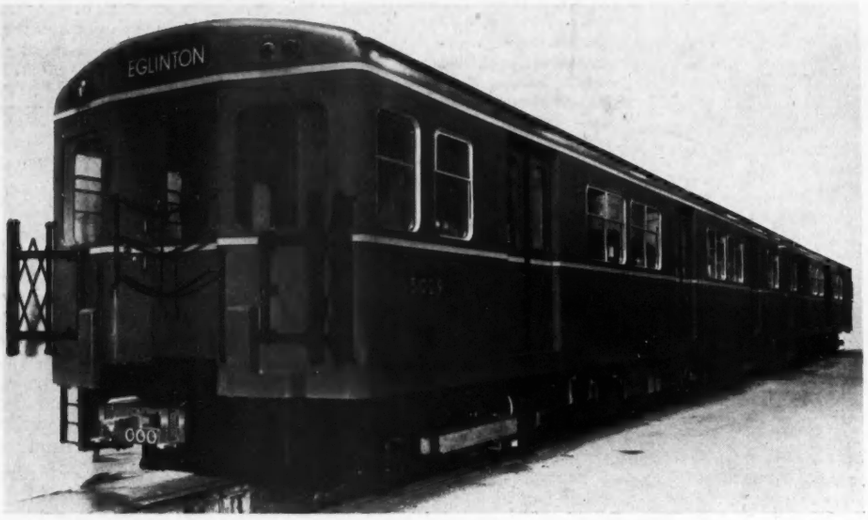


Fig. 1 British-built electric car for the subway which has been constructed in Toronto to relieve traffic congestion on Yonge-street.

ELECTRIC SUBWAY CARS FOR TORONTO

COMPARISON OF ALUMINIUM AND STEEL CONSTRUCTION

The vehicle subway which has been constructed under Yonge-street, Toronto, to relieve the traffic congestion in a main artery of that city is to be opened to the public on Tuesday, March 30. Its civil engineering features have already been described in ENGINEERING*, but it may be recalled that it is about 4·75 miles long with a total rise of 280 ft. and a maximum gradient of 3·5 per cent. About 2·7 miles are underground where the structure is of reinforced concrete in box sections, 17 ft. 7⅛ in. deep and 32 ft. 6 in. wide overall. The two track tunnels, which are each 13 ft. 6 in. wide by 13 ft. above the rails, are separated by a 1 ft. 6 in. wall with a 2 ft. footpath on each side.

At the 12 stations the subway structure measures 18 ft. 3¼ in. by 52 ft. 4 in., the platforms being 11 ft. 10 in. wide and 500 ft. long, so that a train of ten 48 ft. cars can be accommodated. Escalators are provided at the deep stations. In the tunnels the 100 lb. per yard rails are laid on a malleable iron plate, below which is a rubber pad, and are bolted to the concrete floor. The running rails are Thermit welded, so that they can be used as an earth return. The gauge is 4 ft. 10⅞ in., to enable the existing tram-cars to be run over the railway tracks. The third rail is laid outside the running rails and is covered by inverted L-shaped wooden boards. Three-colour automatic signalling and train stops have been installed.

The rolling stock for the subway consists of 104 cars, which have been built in this country by the Gloucester Railway Carriage and Wagon Company, Limited, Gloucester. These cars, which are illustrated in Fig. 1, are 57 ft. long over the bumpers, the length of the body being 54 ft., and the width over the doors 10 ft. 4 in. while the height is 12 ft. The bogie wheel base is 7 ft. and the wheel diameter 2 ft. 6 in. The seating capacity is 62 passengers with a total accommodation for 230. The underframes and bodies are of steel construction, although considerable use has been made of aluminium, all the doors and seating framing being of that material. Four cars of all-aluminium construction are also in course of manufacture. All the steel cars will be available for service on the opening date.

The bogies are of the Gloucester Company's design and the suspension system consists of laminated and triple-coil helical springs with spring-loaded friction pads to ensure adequate damping. Roller bearings and solid steel wheels are employed throughout. One of the bogies is shown in Fig. 2.

Each bogie is equipped with two 68-h.p. series motors, which were manufactured by Crompton Parkinson, Limited, Aldwych, London, W.C.2. These motors are connected in series across the 600-volt supply and are provided with field weakening. They will be capable of accelerating a fully loaded car at the rate of 2·3 m.p.h. per second and of reaching a maximum speed of 55 m.p.h. They have skewed slots to reduce the noise and are cooled by self-contained fans.

* See ENGINEERING, Vol. 171, page 177 (1951).

Fig. 2 The bogies each have two 68-h.p. 600-volt motors and Hypoid axle units.

The drive from the motors, which are frame-mounted and spring-born, is through pinion and hypoid axle units manufactured by David Brown and Sons (Huddersfield), Limited, as shown in Fig. 3, the gear ratio being 7 to 2. Both the pinion and the gearing are of nickel-chrome case-hardened steel, the former, which is forged solid with its shaft, being carried in a cast-steel housing. A forged steel centre, to which the hypoid gear is bolted and dowelled, is extended to form a sleeve which is mounted on roller bearings. This enables the complete unit to be pressed direct on to the axle without dismantling; and assembly in the car frame to be simplified. The main casing, which forms the oil-bath, is fabricated from mild-steel plate.

ELECTRICAL CONTROL GEAR

The electrical control gear, which was manufactured by the British Thomson-Houston Company, Limited, Rugby, is designed for the control of one, two, three or four car units from a cab at the outer end, which may be used by either the driver or the guard. The equipment comprises a number of electro-pneumatic units, including a cam-operated contactor group which controls the acceleration. In this system, each contactor in closing cuts out a section of the starting resistance through a camshaft, a pinion on which engages with a rack mounted between two pistons in a cylinder. One of these pistons is operated by oil and the other by air pressure, the camshaft notching up under the former to the full series position in nine steps. Point-to-point movement is controlled by a relay, which arrests the camshaft through an electrically-operated pawl and star wheel. When the full series position has been reached the two pairs of motors are connected in parallel by a switch, each with its own section of resistance re-inserted. The oil pressure is then released so that the camshaft is rotated in the opposite direction by air under the control of the relay. The starting resistance is thus cut out step-by-step, so that when the camshaft reaches its initial position the two motors are connected in full parallel. In addition, the two steps of field weakening are under current control.

The main items of the control equipment, including the two electro-pneumatically operated line breakers and reverser, are mounted in an aluminium-alloy framework on the underframe. The two line breakers have extension arc chutes and all the power cables are provided with "quick release" connectors to facilitate the removal of the complete unit. The starting resistors are of aluminium-chromium alloy steel

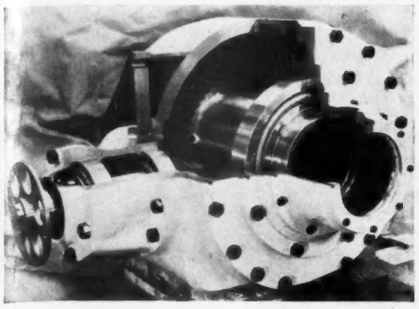


Fig. 3 Hypoid axle unit (cut away to show the components) which transmits the drive from the traction motor to the axle.

strip and are mounted in an angle iron framework under the car, tertiary insulation being provided.

The cab equipment includes a master controller of the shallow desk type, which is cam-operated and has only three working positions. In the "shunt" position all four motors are connected in series with the starting resistances while in the "series" position the resistance is all cut-out and the motors are in series across the supply. In the "parallel" position the motors are in series-parallel, while in the same position the field weakening steps are operated automatically under current control. A switch enables the driver to select one of three rates of acceleration which can then be maintained under varying load and rail adhesion conditions.

The master controller is arranged for left-hand operation and is fed from a relay, the operating coil of which is energised through the door interlocks, of which there are 96 in series on an 8-car train. Each door is provided with a combined cut-out and shorting switch, while in emergency the control relay can be cut out by a sealed master switch in the cab. To the right of the master controller is the electro-pneumatic brake controller. The rate of braking is controlled by two mercury retarder switches, while there are push buttons for the door control and inter-car signalling and a number of indicating lamps showing the position of the doors, the condition of the electro-pneumatic brake and retarder supplies, as well as when the auxiliary motor-generator is not operating and when all the traction control units on the train have moved to the final parallel position. A second series of buttons is provided for controlling the motor-generator, one of which enables it to be switched on by the maintenance staff if required for car heating. Four of the steel cars and the four aluminium cars mentioned above will be fitted with meters so that their current consumption can be compared.

BRAKING SYSTEM

The brakes, which are of the electro-pneumatic type, were manufactured by the Westinghouse Brake and Signal Company, Limited, Kings Cross, London, N.1. The system incorporates a retardation controller consisting of a U-tube containing mercury. The movement of this tube makes or breaks electrical contacts and thus enables the train to be brought to rest as smoothly and rapidly as possible.

A supply of power for the traction motor control circuits, doors, brakes, heating, ventilation and lighting is obtained from a 4-kW Crompton Parkinson motor-generator, the motor of which is operated at the track voltage. This set is suspended from the underframe on rubber blocks, thus reducing noise. The full output of the generator can be obtained at any line voltage between 450 and 600 volts and its output is controlled by a carbon pile regulator.

Heating and ventilation will be supplied by 30-kW under-floor resistors over which air will be circulated to the car through seat-pedestal louvres. The temperature will be maintained between 62 and 65 deg. F. by thermostats. The lighting will provide an illumination of 25-foot candles on the reading plane. Both the heating and lighting systems have been supplied by J. Stone and Company, Limited, Deptford, London, S.E.

The traction control units may be tested without applying power to the motors by pressing a button and operating the master controller, correct operation being indicated by the lighting of a lamp. A test socket is provided in each cab to facilitate rapid location of a fault. Each car has a double-pole double-throw test switch which can be used in conjunction with a 600-volt plug and trailing cable. When this switch is in the test position the traction and heater circuits are isolated but a supply is available for the motor-generator compressor and lighting.

PLATE BENDING MACHINE

MINIMUM FLAT EDGES ON CONES OR CYLINDERS

A machine designed to bend plate, in one rolling pass, into a cylindrical shape, and to leave the least margin of flat on the long edges, has been built by the Bronx Engineering Company, Limited, Lye, near Stourbridge, Worcestershire. This machine, the Bronx 3-roll initial-pinch type plate bending machine, Series 3IP86, has a rated capacity of 8 ft. by $\frac{3}{4}$ in. thick mild steel plate; and for plate of half this size or less, the extent of the flat edge will, it is claimed, be equal to the plate thickness. The machine incorporates a swing-down end housing to permit the unloading of formed cylinders from the top roll. Adjustments to the lower rolls may be performed with the aid of electric motors to prepare the machine for conical work or changed plate thickness.

The centre bottom roll is adjusted vertically in order to secure the plate, and the adjustment is performed by means of a 3-h.p. electric motor, thus enabling the operator to remain in the main operating position. Known as the pinch roll, it can be set according to the plate thickness and tilted for conical work.

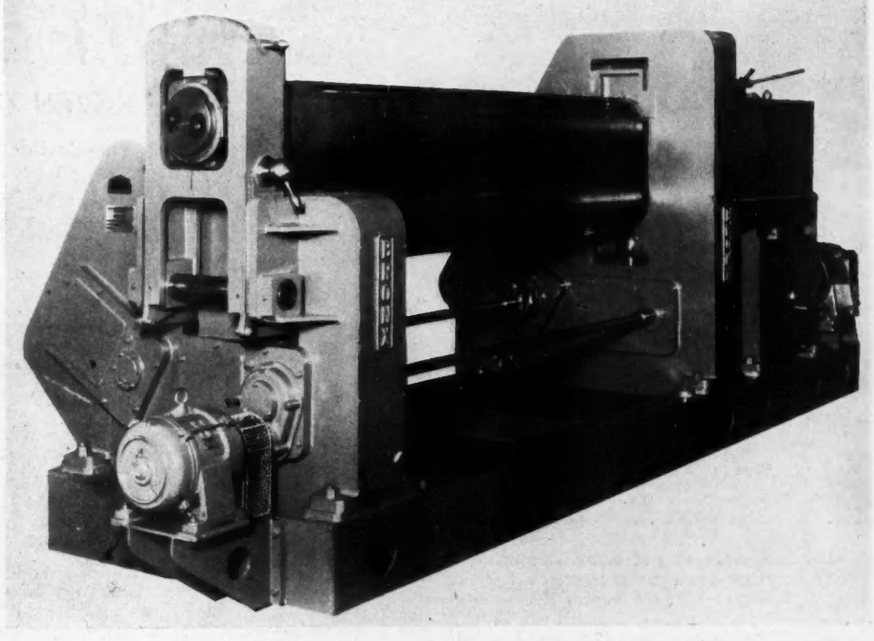
The side bending roll is separately adjusted by an independent 12-h.p. motor, which is directly coupled to the worm gearing in the housings and is controlled by push buttons and a "direct-on" reversing starter. This roll can also be tilted for conical work. In order to permit the roll to operate in that position, a multi-jaw clutch is fitted to each driving shaft. The setting of the side bending roll is recorded by pointers on a graduated scale mounted alongside the roll chocks.

The top roll is not adjustable, but is provided with a long counterbalancing extension for supporting the roll when the terminal bearing swings down.

The rolls are machined from forgings of 0·45 to 0·5 per cent. carbon steel with a high elongation value, and are 13 in. in diameter. The top and bottom centre rolls are driven by a 25-h.p. motor and the side bending roll is idle.

The rolls are housed in a heavy fabricated steel casing, the lower part of which encloses the worm gearing for adjusting the bottom centre roll. Both lower rolls are set by means of screws driven by worm gears, made of phosphor bronze; the remaining gears, which embody machine-cut helical teeth, are of steel. The gearing is totally encased, both in the roll housing or the main drive housing, and runs in oil. Phosphor-bronze-lined bearings carry all but the high-speed shaft, which is supported in ball and roller bearings.

To supply power for the main drive the machine incorporates the 25-h.p. slip-ring motor, giving 945 r.p.m. It is regulated by a tramway-type controller with wire-wound resistance.



The Bronx three-roll initial-pinch plate bending machine.

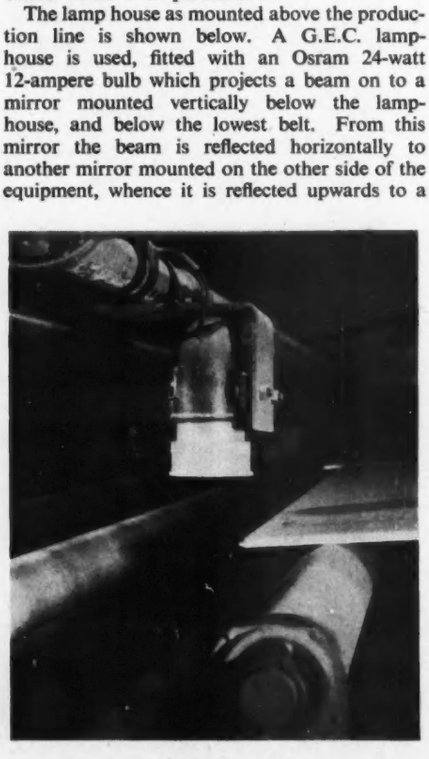
CONTROL OF CONVEYOR-BORNE PARTS

Photo-Electric System for Converging Conveyors

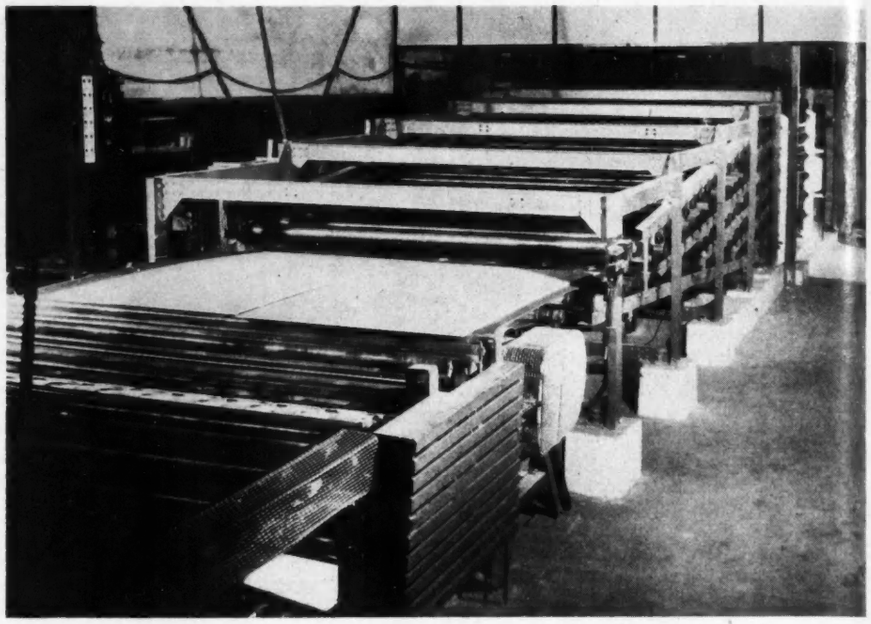
Increased production rates at the Rochester factory of Gyproc Products, Limited, have involved the installation of additional mechanical-handling machinery, the efficient operation of which has been assisted by the use of photo-electric control equipment supplied by the General Electric Company, Limited.

The plasterboard sheets, which may vary in length from 6 ft. to 12 ft., are passed through a long drying kiln by means of six conveyors mounted one above the other. On leaving the drying kiln the boards are brought from the six decks to a single conveyor line which takes them automatically to an edge grinding and bundling machine. The convergence of the conveyors is shown on the right. Some form of control is necessary to ensure that the six conveyor lines from the kiln feed the boards on to the single-line conveyor at regular intervals without any risk of the boards overlapping. The G.E.C. photo-electric control equipment was installed to avoid this possibility and results have been satisfactory. Each of the six conveyor lines leaving the drying kilns leads to its own motor-driven speed-up conveyor section which, when switched on, shoots the Gyproc board on to the single-line conveyor. This section forms the back of the conveyor as shown on the right. The photo-electric control equipment ensures that none of these conveyor lines will feed on to the single-line conveyor until the previous deck has been cleared, and the process timing equipment allows the operator to pre-set the interval between each to suit the particular length of board which is in production

The lamp house as mounted above the production line is shown below. A G.E.C. lamphouse is used, fitted with an Osram 24-watt 12-ampere bulb which projects a beam on to a mirror mounted vertically below the lamphouse, and below the lowest belt. From this mirror the beam is reflected horizontally to another mirror mounted on the other side of the equipment, whence it is reflected upwards to a



The light-source is mounted above the top layer ; the light goes down to a mirror below the bottom layer, is reflected across the machine and thus up to the photo-cell which can be seen in the background. Thus either of the boards, on any layer, will cut the beam.



The six layers of boards from the kiln converge to a single conveyor. Photo-electric controls ensure that the boards are delivered at properly spaced intervals.

G.E.C. relay amplifier, fitted with a 4-in. lens attachment to concentrate the beam, which can also be seen below. Altogether, the beam travels about 20 ft. from lamphouse to photo-cell.

As the board moves along the production line it interrupts the beam, and the photo-cell, through the associated relay amplifier, activates a Chamberlain and Hookham process-timer mounted on the side of the production line. This timer, operating through a relay mounted immediately above it, at once switches off the bulb in the lamphouse. Then at the end of a timed interval, which can be anything from 0 to 100 seconds, the process-timer operates a Witton-Kramer solenoid to switch on the electric motor rotating the rollers for the next conveyor line take-off, the motor for the previous line being switched off at the same moment.

Simultaneously, the process timer, through its associated relay, switches on the bulb in the lamphouse again, so that the equipment is ready for the next set of boards passing through.

Thus the process timer enables differences in speed through the kiln, due to the different drying times required by various thicknesses of board, to be accommodated, while intervals between successive boards on the final single belt can also be controlled. Finally, since the light beam from the lamphouse is passed through each side of the production line, the photo-electric control equipment will still operate even when a single board, occupying only one side of the conveyor belt, passes through.

ELECTRIC LOCOMOTIVES FOR MANCHESTER–SHEFFIELD LINE

FIRST OF SEVEN UNDERGOING TRIALS

We are now able to give some further details of the seven 2,500-h.p. Co-Co locomotives for the Manchester-Sheffield-Wath electrification scheme the first of which, as announced on page 120, *ante*, is now undergoing trials between Dukinfield and Crowden.

These locomotives, the appearance of which will be clear from the illustration opposite, are 59 ft. long over the buffers, the wheel base being 46 ft. 2 in. and the distance between the bogie centres 30 ft. 6 in. The overall width is 8 ft. 10 in. and the weight in working order 102 tons.

The underframe is made up of rolled steel sections, cross braces and stiffeners being incorporated over the bogie centres. The bogies are of the box type and have been fabricated from $\frac{1}{2}$ in. plates, their centres being on the centre line of the axle boxes. They are braced by two cast steel cross-stays in which the double bolster can slide transversely and through which the tractive force is transmitted to the bolster and the bogie centre on the body structure. The weight of the bodies is carried on four spherical bearers which slide on each bolster. The bolsters, in turn, rest on laminated springs, which are supported by swing links from the bogie cross-stays. Equalising beams, which rest on the tops of the axle bogies, are suspended from the inside of the frames by tension bolts and twin nests of springs. The axle boxes have Timken roller bearings and slide in horn gaps, which are faced with manganese steel liners. All this mechanical equipment is being built at the Gorton works of British Railways.

DRIVING ARRANGEMENTS

Each of the six axles is driven by a nose-suspended motor, which is supported by a link from cross-stays. These cross-stays are carried in Silentbloc bearings and are located laterally by a smaller bearing to prevent contact between the wheel bosses and the motor bearings, all the movement being taken up by the Silentblocs. The drive to the axles is through single resilient reduction gearing with a ratio of 17 to 64.

Of the three traction motors on each bogie two are permanently connected in series and

three different speed ranges are obtainable. The motors are separately excited from a motor-generator in one of the machinery compartments. This machine also drives the blower for cooling the motors at that end. There is a similar blower in the other compartment. This is driven by a motor-generator set which also supplies current at 50 volts for operating the control gear and charging the battery, for lighting and for the electrically-heated boiler.

The control gear is of the electro-pneumatic type and is operated through contactors from the master controllers in the cabs, the layout of which is similar to that of the Bo-Bo locomotives now in service on the Wath branch. Both cabs contain, in addition to the master controller and auxiliary switches, the air and vacuum brake valves and an instrument and gauge panel. There is a push button on the right hand side of the desk so that the operation of the deadman's handle can be prevented should the driver wish to cross from one side of the cab to the other.

The cabs are connected by a corridor along one side from which access can be obtained to the high-tension and resistance cubicles and to the compartments containing the boiler and auxiliaries. The door to the resistance chamber is mechanically and electrically interlocked by the reverser key on the master controller and can only be opened when the pantographs are lowered.

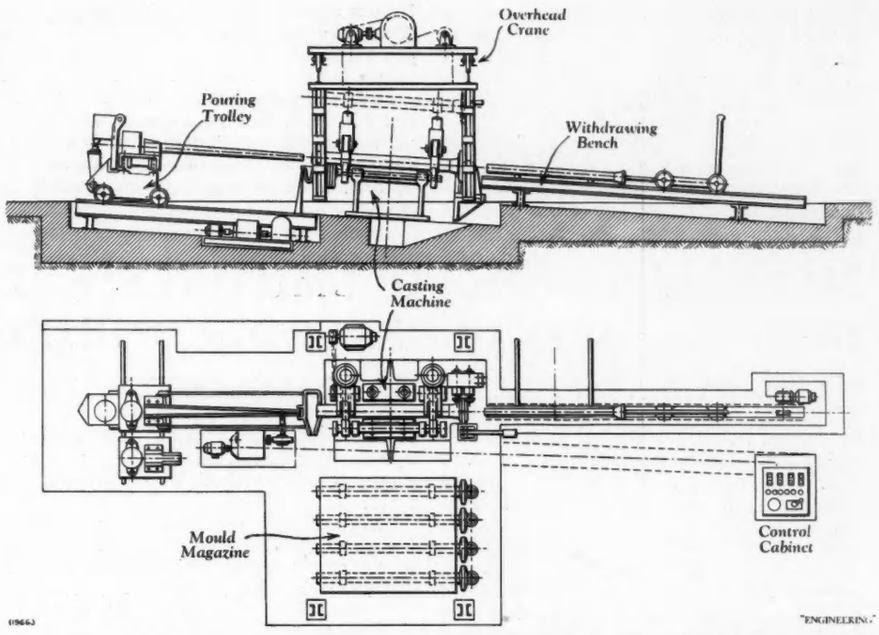
BRAKE GEAR

The brake equipment consists of a Westinghouse vacuum-controlled straight air system for the train and a compressed-air system for the locomotive, both systems coming into operation if the deadman's handle is actuated or a break-away occurs. The locomotive brake can be operated either separately or in synchronism with the train brake. Regenerative braking is provided.

Compressed air for braking, sanding, operating the horn and other purposes is obtained from a motor-driven compressor and the vacuum from a Westinghouse motor-driven exhauster. There are four brake cylinders on each bogie and the rigging is operated through Westinghouse slack adjusters.

The electrical equipment for the locomotives is being supplied by the Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17.

The first of seven 2,500-h.p. Co-Co electric locomotives for the Manchester-Sheffield-Wath electrification scheme of the London Midland Region, British Railways.



Elevation and plan of a German centrifugal casting machine for iron pipes. Its hourly production rate is said to be up to 40 cast-iron pipes 4 in. in diameter and 6 ft. 6 in. long.

CENTRIFUGAL CASTING OF IRON PIPES

Originally intended for the production of spun cast-iron pipes, the centrifugal casting process of late years has been extended to steel and various non-ferrous metal alloys. Thus, it is employed for the production of all kinds of thin-walled pipes and connections made from heat-resisting and corrosion-resisting chromium-nickel steels, and for casting bearing bushes, gearing blanks and coupling components of copper alloys. Piston-ring pots, single rings, cylinder liners, flanges, coupling discs and other articles are now centrifugally cast in iron.

According to the form and size of pieces to be cast, a centrifugal casting machine may have either a horizontal or a vertical rotating axis, the former type being employed for castings having a length several times that of the diameter, while the latter is used for castings having a large diameter compared with their length or height. The general layout of a plant of the horizontal-axis type built by Ardeltwerke G.m.b.H., of Wilhelmshaven, for the production of cast-iron pipe and, it is understood, embodying the latest German practice in this field, is seen in the illustrations above.

The installation comprises five main pieces of equipment, namely, the casting machine, the pouring equipment, the withdrawing bench, the mould magazine, and the overhead transport crane. The casting machine, in the centre of the plant, consists of a foundation plate on which are mounted the bearings carrying four rollers serving to support and rotate the cylindrical mould. Between the bearings is a hydraulic cylinder used for the insertion and extraction of the mould, while two hinged steadying arms are provided to maintain the mould on its supporting rollers when rotating.

The second main item of equipment consists of a trolley running on rails and comprising a receiving ladle and a pouring ladle fitted with an elongated spout. The arrangement is seen on the left in the illustrations.

The withdrawing bench is shown on the right of the casting machine. It is used for removing the cast pipe from the mould and consists of an electrically-operated carriage fitted with gripping tongs which discharge the hot casting into a chute alongside the apparatus.

In front of the casting machine is the mould magazine, a steel-frame structure having a capacity for four moulds. It is equipped with gas burners for pre-heating the moulds at the commencement of a shift and with air-blast apparatus for cooling them down quickly when this is necessary. The rotation of the moulds in the magazine is effected by a separate electric motor through reduction gearing.

The fifth main item of equipment, the overhead electric transport crane, is used for mould changing. The crane runs on a track above the magazine and the casting machine, supported on four steel columns.

The operation of the plant follows established routine. Molten metal is first poured into the receiving ladle of the trolley, which is advanced until the long pouring spout reaches the further

end of the heated and rotating mould, mounted in the casting machine. As soon as the spout reaches the far end of the mould, the receiving ladle is slowly tilted by an automatic device and the metal flows through the spout into the rotating mould. At the same time, the pouring trolley is withdrawn gradually and as soon as it is back in its original position the rotation of the mould is stopped and the cast pipe withdrawn. The operations are controlled by means of push buttons arranged on the cabinet on the right, where the chargehand takes his stand. The pouring temperature of the metal for the process ranges from 1,220 deg. C. to 1,260 deg. C., according to the nature of the casting required, and the actual pouring operation takes about six seconds. It is stated that between 30 and 40 pipes, each measuring 4 in. in diameter by 6 ft. 6 in. in length, are produced in an hour.

NARROW-GAUGE LOCOMOTIVES FOR SURFACE AND UNDERGROUND DUTY

HYDRAULICALLY OPERATED GEARBOX

Two Diesel locomotives for use on the surface and in gas-free mines, on tracks of 1 ft. 6 in. to 3 ft. 6 in. gauge, have been introduced by Ruston and Hornsby, Limited, Lincoln. They will supersede earlier models known as the Mark 20DL and 30DL. The compact design, which is one of the main features, gives an overall length of 7 ft. 6 in. and a height of 4 ft. 3⅜ in. When a driver's cab is fitted, the height is increased to 6 ft. 3 in. The width varies with the gauge; for a gauge of 3 ft. 6 in., it is 4 ft. 7¾ in. The models for surface work are known as the Mark LAT and LBT and for underground work, Mark LAU and LBU.

The LA models have a total weight of 3½ tons and are fitted with a Ruston and Hornsby two-cylinder VSHL Diesel engine, which develops 20 brake horse-power at 1,200 r.p.m. Either a two-speed or three-speed gearbox can be fitted and the maximum tractive effort, 1,890 lb., is attained at speeds in the region of 1·4 to 2·6 m.p.h. For the same conditions the drawbar pull is 1,813 lb.

The LB models are built to a total weight of either 3¾ or 4½ tons and have a three-cylinder VSHL engine, which develops 30 brake horse-power. These may also have either a two-speed or a three-speed gearbox. The heavier version has a maximum tractive effort of 2,430 lb. and a drawbar pull of 2,331 lb. between 1·15 and 2·55 m.p.h. The engine idles at 550 r.p.m.

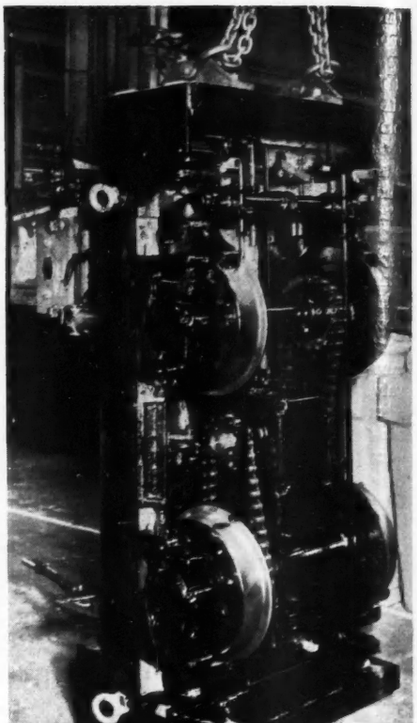
The other feature of particular interest on this locomotive is the constant-mesh gearbox, also designed and constructed by Ruston and Hornsby. It is hydraulically controlled and operates over the full speed range in both directions. A separate clutch is used to select each speed.

The clutch shaft, connected to the engine by a flexible coupling, has two clutch housings keyed to it. One housing accommodates both the first- and second-gear clutch facings and spinners, and the other, the third-speed clutch. The clutch facings, chill cast in phosphor-bronze, are secured to the clutch housing. The steel clutch spinners, which move axially to engage the clutch faces, are dogged to their respective gears and the gears run on roller bearings.

When a gear is selected, oil is fed from a control body through internal piping and a hole in the clutch shaft to the appropriate clutch. As the oil pressure builds up, a clutch ring moves the spinner axially and closes the gap between the spinner and the clutch face; this arrangement ensures that the load is taken up smoothly. A further build up of pressure closes a spring-loaded outlet valve so that the full pressure necessary to engage the clutch completely can be reached. A constant bleed of oil from the clutch prevents air locks and in addition provides cooling for the clutch unit.

With the selection of neutral or another speed, the clutch release is instantaneous and the reduction in pressure permits the outlet valve to open. Centrifugal force empties the clutch quickly and the spinner is returned to the free position by compression springs.

The selected clutch transmits the power to the final-drive shaft through gear trains mounted on the lay, intermediate and final bevel-pinion shafts. Forward and reverse are selected by engaging a dog clutch between the bevel wheels which are mounted on roller bearings on the final-drive shaft, and an interlocking device is fitted in the control system to ensure that the direction-change lever cannot be operated until the change-speed lever is in the neutral position.



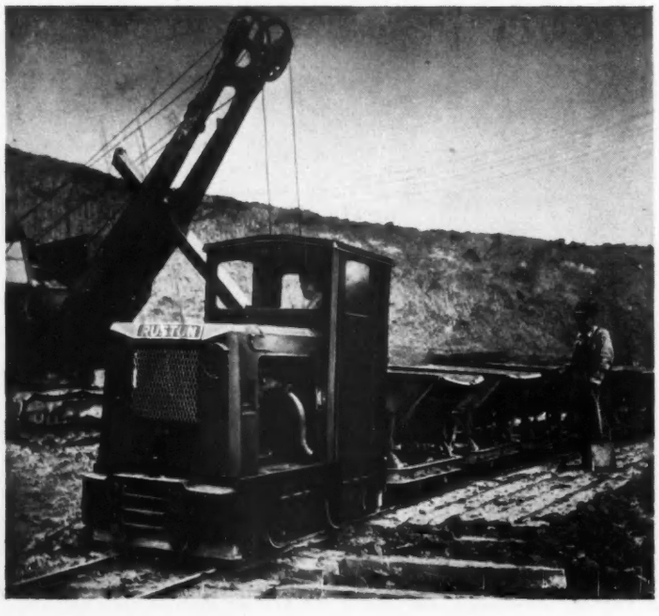
The layout beneath the frame is similar for models LA and LB. The frame is of welded construction and heavy-chain drives link both axles with the gearbox.

The frame of the locomotive is fabricated from rolled-steel sections; some idea of the layout can be obtained from the illustration above. The drive is taken equally to both axles by roller chains which have drip-feed lubrication and if required these driving chains can be enclosed in oil-bath cases. The axleboxes are of the plain type fitted with bronze bearings and an oil sump and pad. A seal is provided to make them dust-proof. The box is carried on a single coil spring and is pivoted at one end so that it has a radial movement with the spring action to maintain the chain centres.

The brakes, operated from the cab by a lever, act on all four wheels and the brake action is compensated so that the load is distributed evenly to each brake block. Sand boxes are fitted at each end of the locomotive. Electric starting can be fitted and electric lighting equipment, which is standard on the mines locomotive, can be fitted to the surface model.

The drawbar height for the link and pin couplers on the 3½- and 3¾-ton models is between 7 in. and 13¼ in. and for the 4½-ton model 6⅜ in. to 18⅞ in. For hauling, the minimum curve radius recommended is 30 ft., but when running light a curve of 15 ft. radius can be negotiated.

On the mines locomotive, an exhaust scrubber is fitted which is readily accessible and requires the minimum of attention.



Type LAT narrow-gauge locomotive with completely-enclosed cab, in use in a quarry.

TRANSISTORS

THEIR USE AND OPERATION

The use of electronic instruments has now extended to most industries and consequently, the development of the transistor, which offers many new possibilities to the electronic engineer, has an interest for many people. For some applications the transistor can fulfil the functions of the valve and, since it is both smaller and more robust, its use will permit the manufacture of instruments which will occupy less space and withstand rougher handling. The transistors at present available are particularly suited for use in telephony. They are, in fact, to be used in the relays of the new Atlantic cable, but can also be employed in many other branches of electronics where the operating frequencies are suitable. Having a very low current consumption, about one hundredth of that of a valve, great operating economies can be effected and the transistor can be used in circuits which could not supply enough power to operate a valve. Although one of the newest electronic devices, the transistor is actually a descendant of the crystal detector used in early radio sets. Two types are now available, known as the point-contact and junction types having different characteristics. A prototype model of the point-contact type was described in ENGINEERING, vol. 176, page 126 (1953). This article is based on material supplied by Amplivox, Limited, 2 Bentinck-street, London, W.1.

GERMANIUM AND "HOLES"

Unlike the radio valve the transistor functions on the principle of controlled electron flow within a solid. Certain solids, called semi-conductors, have specific resistivities greater than that of copper, but less than that of glass. Since the resistivity of a semi-conductor increases as its degree of purity increases, the electrical characteristics of such a material can be precisely controlled by regulating the amount of impurity present. If the atoms of the impurity have more electrons in their outer orbit than do those of the pure semi-conductor, an excess of electrons results and an N-type (negative-carrier) semi-conductor is formed. Conversely, a P-type (positive-carrier) semi-conductor is produced if the atoms of the impurity contain fewer electrons in their outer orbit than those of the pure-semi-conductor.

It is this deficiency of electrons in the P-type semi-conductor that results in the phenomenon called "holes." For most purposes, these holes may be considered equivalent to positively charged particles that contribute to the current flow within the semi-conductor. Semi-conductors, therefore, introduce an extension of the familiar concept of electron conduction by utilising, in addition to electron flow, the movement of holes. This simultaneous conduction of holes and electrons contributes to the amplification capabilities of the transistor.

At present, all commercially available transistors utilise germanium as the semi-conducting solid. Other materials, however, are being investigated to determine if the capabilities of present transistors may be extended. The two main types of germanium transistors, point-contact and junction, differ both in the physical configuration of the germanium and in the way in which they utilise its properties to achieve amplification.

THE POINT-CONTACT TRANSISTOR

The point-contact transistor, the older of the two types, usually consists of a single pellet of N-type germanium with two cat-whisker contacts, the emitter and collector, spaced a few thousandths of an inch apart on the germanium surface; the third connection, the base, makes area contact with the germanium. The N-type pellet, no larger than the head of a pin, also has P-type areas around the emitter and collector which are formed by special processes in the final stages of manufacture.

To simplify understanding of the transistor, it is helpful to note the similarity between the elements of the transistor and those of the familiar valve. Functionally, the emitter corresponds to the cathode of the triode valve, the collector to the plate, and the base to the grid. In comparing the transistor and the triode valve, it is also helpful to note that the voltage applied to the collector of the point-contact transistor using N-type germanium is opposite in polarity to that applied to the plate of the valve.

Fig. 1 illustrates a typical point-contact transistor circuit with an enlarged view of the internal operation of the transistor itself. Under the influence of the positive bias on the emitter, electrons are carried into the emitter circuit. This action produces holes in the emitter region. These holes, attracted by a negative voltage on the collector, travel to the collector region and allow electrons to pass more easily from the collector into the germanium. Some of these electrons combine with the holes, the majority, however, travel to the base.

This phenomenon may be roughly compared to the space-charge effect in a valve. For explanation purposes, imagine a positive space-charge surrounding the cathode in place of the usual negative space-charge. The presence of this imaginary space-charge would attract more electrons from the cathode and thus increase the current flowing within the valve. Essentially the same action takes place in the collector region of the point-contact transistor.

The presence of the positively charged holes around the collector reduces the height of the P-N barrier and increases the current from the collector to the base. The relative mobility of holes and electrons permits a larger number of electrons to enter the germanium under the influence of a smaller number of holes. Thus a change in the emitter current causes a relatively larger change in the collector current. A point-contact transistor, consequently, produces a current gain greater than unity. In fact, current amplification factors of the order of two or three are not uncommon for this type of transistor. For a common-base connection, the current amplification factor is defined as the ratio of the change in collector current to the change in emitter current at a constant collector voltage.

Another distinguishing feature of the point-contact transistor is its capability of working at high frequencies. The maximum operating frequency of the ordinary point-contact transistor is approximately 10 megacycles, although special ones have been operated at up to 300 megacycles. Its high current gain and its high-frequency capabilities make the point-contact transistor a desirable component in radio-frequency oscillators and amplifiers, intermediate-frequency amplifiers, and switching circuits.

THE P-N-P JUNCTION TRANSISTOR

As previously stated, the junction transistor differs from the point-contact type in physical appearance and principle of operation. The junction transistor physically resembles a "sandwich." This sandwich consists of germanium wafers arranged in positive-negative-positive sequence in the P-N-P type, and in the reverse order in the N-P-N type. The middle layer of this germanium sandwich is called the base; the outer layers are the emitter and collector. As in the point-contact transistor, the analogy may be drawn between the elements of the junction transistor and those of a valve. Functionally, the P-N-P junction transistor utilises holes for conduction. The type is shown diagrammatically in Fig. 2 which also illustrates the internal operation of the sandwich. It is to be noted that, although the voltages required for the P-N-P junction transistor are smaller than those required for the point-contact type, the polarities are similar.

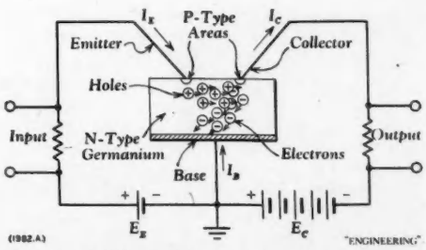


Fig. 1 Point-contact type transistor: an enlarged diagrammatic cross-section with associated circuit.

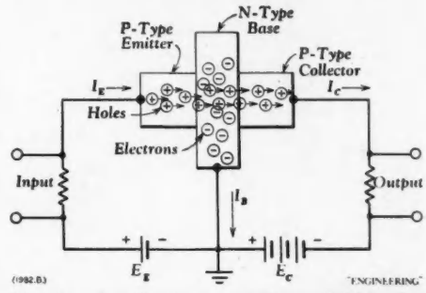


Fig. 2 Junction-type transistor, P-N-P formation: enlarged diagrammatic cross-section with simple grounded-base circuit.

In the P-N-P junction transistor, variations in the emitter circuit cause variations in the number of holes in the base. Since this type of transistor uses holes for conduction, it is logical that a change in the supply of holes from the emitter will alter the number of holes moving through the base to the collector. In fact, a change in the emitter current causes an almost equal variation in the collector current. Appreciable power gain is produced by a variation of current through the high-impedance collector caused by an almost equal current change through the low-impedance emitter. Since the number of holes reaching the collector is always fewer than the number starting from the emitter (some holes combine with the electrons in the base), the current amplification factor of the junction transistor is less than unity in the grounded-base circuit. This characteristic contributes to the stability of the junction transistor in electronic circuitry.

It can be seen that the physical arrangement of the closely spaced wafers of germanium resembles that of a capacitor. Actually, this physical arrangement does produce a capacitance effect that may limit the frequency of operation to the spectrum below 200 kilocycles, unless measures are taken to lower the base resistance. Further characteristics of the junction transistor are: low noise factor, low input power requirements and high power gain. The present junction transistor can be used in amplifier and oscillator circuits in the low-frequency range.

This tractor is a development of the Massey-Harris model No. 744D and uses a Perkins Diesel engine. It can be fitted with a three-point linkage and hydraulic lift for use with implements built to B.S. 1841 : 1951, Category 2.

45-H.P. DIESEL TRACTOR

PROVISION FOR IMPLEMENTS

The tractor shown in the illustration above is being produced by Massey-Harris-Ferguson (Manufacturing), Limited, at their Kilmarnock factory, Scotland. It is a development of the 744D tractor and will be known as the 745. It is fitted with a Perkins L.4 Diesel engine which develops 45 b.h.p. at 1,500 r.p.m., and is said to have a higher power output and a lower fuel consumption than its forerunner. A sustained pull of 5,800 lb. can be exerted on the drawbar.

The tractor can be fitted with a three-point linkage and hydraulic lift, and is designed for use with implements built to B.S. 1841 : 1951, Category 2. The pump for operation of the hydraulic lift is mounted at the front of the tractor, and takes its drive direct from the crankshaft. This arrangement follows American practice, making the hydraulic pressure feed independent of the clutch. As the system is entirely isolated a light S.A.E. oil can be used and a filter is not required. The control for the lift permits the implements to be raised or lowered, at one of two speeds, and held in any position. A hydraulic connection is also provided in the control circuit so that the slave rams of implements having remote control can be pressure fed.

Tyre Size.	13 in. by 30 in.	14 in. by 30 in.	12 in. by 38 in.
	M.p.h. at an engine speed of 1,350 r.p.m.		
1st Gear	2·21	2·31	2·48
2nd ,, ...	3·33	3·49	3·75
3rd ,, ...	4·43	4·64	4·98
4th ,, ...	5·75	6·02	6·47
5th ,, ...	12·28	12·84	13·80
Reverse Gear ..	2·90	3·04	3·26
	M.p.h. at an engine speed of 1,500 r.p.m.		
1st Gear	2·46	2·57	2·75
2nd ,, ...	3·70	3·83	4·17
3rd ,, ...	4·93	5·15	5·54
4th ,, ...	6·38	6·69	7·19
5th ,, ...	13·63	14·26	15·33
Reverse Gear ..	3·22	3·34	3·62

The tractor engine drives through a Borg and Beck 12AS clutch and the gearbox is fitted with straight spur gears. There are five forward speeds and one reverse; the road speeds are shown in the table. It will be noted that these depend upon the size of the rear tyres.

Rear wheels to suit any of the three tyre sizes given in the table can be fitted to the Rowcrop rear axles, and standard, high-arch or twin-wheel axles can be fitted at the front. The standard front axle is used with pressed-steel or variable-track wheels and 6·00 in. by 19 in. tyres, and the high-arch and twin-wheel axle uses 5·50 in. by 16 in. tyres. The track widths of both the front and rear axles depend on the wheel and size of tyre fitted. The width of the rear axle can be varied from 54 in. to 84 in., and the front axle from 48 in. to 66 in. when using the standard axle with variable tracks, and 54 in. to 74 in. when using the arched axle.

The brakes that are fitted use expanding shoes and operate through individual controls, so that independent braking of the rear wheels can be used to assist in cornering. For road work the pedals can be locked together.

The power take-off, which is regarded as extra equipment, has a 1⅜-in. S.A.E. splined shaft and runs at 534 r.p.m. when the engine speed is 1,350 r.p.m. A pulley for belt-driving auxiliary farm equipment is mounted on the off-side of the tractor adjacent to rear wheel. It is 13½ in. diameter, 6 in. wide, and runs at 863 r.p.m. The belt horse-power at an engine speed of 1,350 r.p.m. is 41·6.

The drawbar, which is the roller type, runs on a steel quadrant, and has a lateral swing of 22 in. The fuel tank holds 20 gallons and two 6-volt batteries are carried.

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EMERGENCY ENERGY FROM A PNEUMATIC JACK

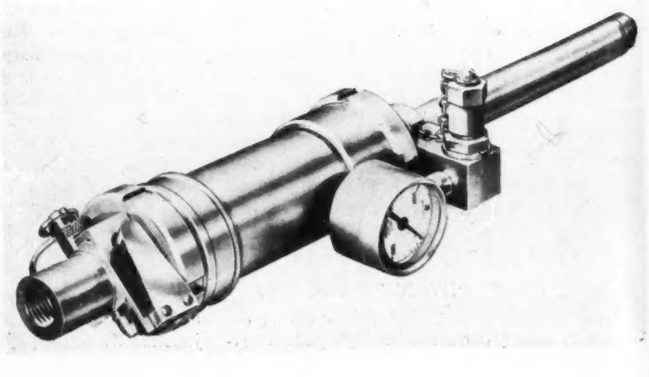
Light-Weight Actuator for Aircraft

A range of light-weight high-thrust pneumatic snap-jacks has been developed by the Hymatic Engineering Company, Limited, Redditch, Worcestershire, for single-shot operation of emergency systems in aircraft, such as canopy ejection, jettisoning fuel drop-tank, and the emergency actuation of locking mechanisms.

In the Hymatic snap-jack, shown in the illustration below, air under a pressure of 3,000 lb. per sq. in. is stored in the hollow spindle of the jack and is retained by a replaceable metal diaphragm in the piston. To actuate the jack, a load of 6 to 8 lb. is applied to an operating pin which fractures the diaphragm, allowing air to pass into the cylinder and acting on the full piston area, to extend the jack very rapidly – in about ⅛ sec. for a 3-in. stroke. Accidental operation is prevented by a safety pin which is withdrawn after installation.

Three types of jack are at present available, all suitable for operating in temperatures of from −40 deg. C. to + 70 deg. C. The largest, utilising a stored energy of 2,200 ft.-lb., develops an initial and final thrust of 9,000 lb. and 2,280 lb. for a 6-in. stroke. The second size, giving 600 ft.-lb., develops an initial and final thrust of 4,750 lb. and 1,250 lb. for a 3-in. stroke; and the smallest jack, utilising 238 ft.-lb., develops initial and final thrusts of 3,500 lb. and 1,000 lb. for a 1·6 in. stroke. The three jacks weigh 3·5 lb., 2·6 lb. and 0·9 lb., respectively.

The self-contained snap-jacks, it is claimed, weigh less than a quarter of a spring providing the same stored energy. They offer no fire risk and are easily charged with air after installation; a pressure gauge can be fitted, as shown in the illustration, to indicate immediately whether the jack is ready for service. The metal diaphragm prevents any loss of pressure with time. For aircraft applications, the elimination of the conventional system of a separate air bottle, selector valve, and ram, with the associated piping, results in a useful saving in space.



Light-weight high-thrust pneumatic snap-jack for "single-shot" operations. The jack, which provides its own self-contained air supply, has been developed for emergency duties in aircraft. Three types are available, with initial and final thrusts of 9,000 lb. to 2,280 lb.; 4,750 lb. to 1,250 lb.; and 3,500 lb. to 1,000 lb.

SLIDEWAY GRINDING ATTACHMENT

REDUCTION OF MACHINE SETTINGS

A grinding head, which can be attached to a variety of machines and which incorporates a truing device to maintain the grinding wheel in correct form, has been made by J. Brockhouse and Company, Limited, Elms Works, Penn-road, Wolverhampton, Staffordshire. It is designed, in particular, for the grinding of machine slideways. When used for this purpose, the grinding wheel is prepared in such a way that, instead of two or three set-ups, one only is required to form the faces of trough or salient slideways. The attachment is supplied in both vertical and horizontal versions.

The vertical head, which has the wider range of slideway grinding applications, is used in general with a cup or cone wheel, set for both edge and peripheral cuts. It is, however, unsuitable for surfacing V-grooves and, for this operation, the horizontal head may be employed. Both horizontal and vertical models may be used for grinding rectangular section slideways.

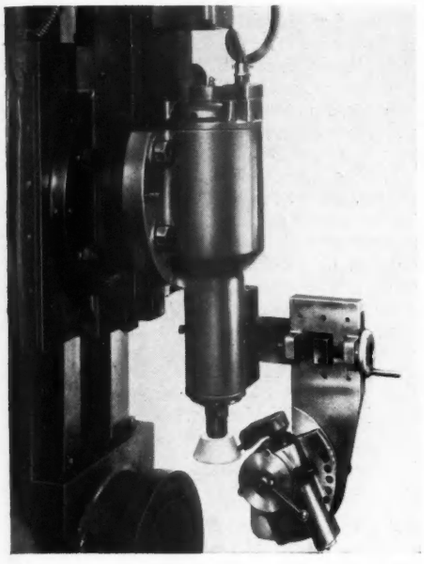


Fig. 1 By means of a truing device, which can be fitted to the vertical head, grinding wheels of various forms and sizes may be dressed.

In Figs. 2 to 4 can be seen the manner in which each head reduces the number of operations necessary to grind slideways of various cross-sections. Three set-ups were required hitherto for grinding the recessed slideway shown in Fig. 2; the new method entails only one. Either version of the head may be used for grinding the faces *a*, *b* and *c* of the rectangular slideway, illustrated in Fig. 3 and one instead of two set-ups are necessary. For grinding V-grooves, the horizontal head must be employed, when the operation can be performed with the grinding wheel again in only one position, as shown in Fig. 4.

The unit grinding heads can be mounted on almost any grinding or planing machine (as in Fig. 1) and some milling and vertical boring machines. Existing machines may be readily adapted and the makers of the grinding attachments provide a service for this purpose.

ADJUSTABLE TRUING DEVICES

Each type of head is supplied with a truing device (Fig. 1), which can be fitted and located as required. In the vertical model the device is inserted into a horizontal slideway, embodied in the main unit, where it can be locked in position. Fine lateral adjustments – to bring the truing tool into contact with the grinding wheel – can be made by means of a small handwheel. The truing device carries a pivoted tool holder, to which may be added a variety of extension pieces chosen to suit a particular truing duty or type of grinding wheel.

The toolholder is set, in accordance with the grinding wheel angle, by means of a locating device, (Fig. 1), similar in function to a dividing head. The holder may be rapidly rotated to a selected angle – for example, to 85 deg., in order to relieve the underside of a cup wheel – and secured in position.

The dressing attachment for the horizontal grinding head is similar in operation and may be set to any angle with the aid of the protractor scale. In both horizontal and vertical versions of this attachment, only one setting of the truing tool is required to give a correctly coned and trued grinding wheel.

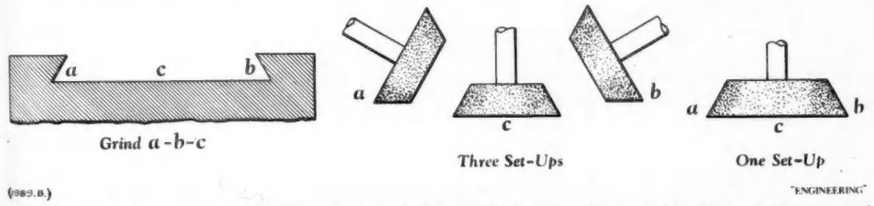


Fig. 2 Three set-ups were hitherto required for machining the faces *a*, *b* and *c* of the recessed slideway shown here. Only a single machine setting is required with this vertical head.

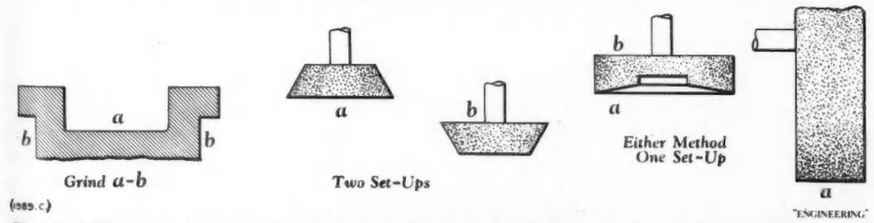


Fig. 3 Slideways of rectangular section can be ground by means of either the horizontal or vertical head, but both methods permit a reduction in the number of set-ups required.

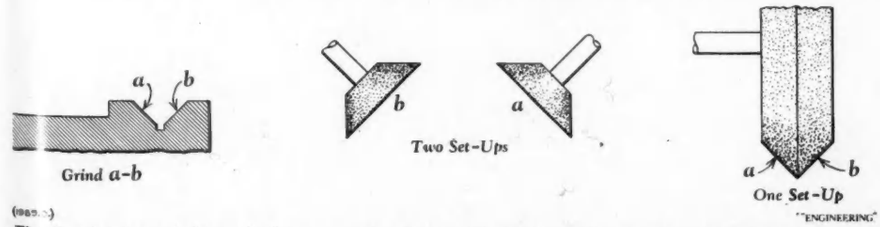


Fig. 4 For the grinding of V-grooves, the horizontal head must be used and both faces of the groove can be machined with the wheel in one position.

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ELECTRIC ARC WELDING OF MOTOR-CYCLE FRAMES

Direct Welding of Mitred Tubes

The frame of a motor cycle usually consists of pre-shaped drawn steel tubing held together with malleable cast lugs and stampings. The assembly of these parts requires accurate jigging, machining and brazing and is accompanied by the risk of distortion owing to the heat. Recently a further complication has been the increasing use of rear wheel suspensions incorporating duplex frames, which, due to their closed construction, are more liable to distortion.

To overcome these difficulties Philips Electrical Limited, Shaftesbury-avenue, London, W.C.2, in collaboration with Ariel Motors, Limited, Selly Oak, Birmingham, have devised an arc welding process for the quantity production of the frames in which use is made of a specially designed electrode. The tubes are mitred and then welded directly to each other. The remaining secondary lugs are next dealt with by the same process, so that only two malleable castings are necessary at the major joint positions. The reduction in the number of intricately shaped castings has thus enabled a large amount of machining to be dispensed with, while frame distortion has decreased and it is possible to employ semi-skilled personnel on the assembly lines with a resulting saving in costs and factory space.

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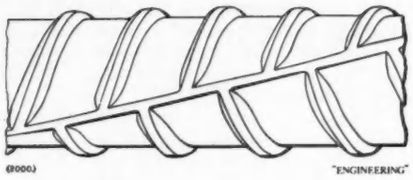
ENGINEERING FOR THE METAL INDUSTRIES

A New Journal

The first issue of a technical publication, *Davy-United Engineering*, which, it is pointed out, has as its basic aim the periodic supply of up-to-date information on the trend of development in that specialised branch of engineering that deals with the building of machinery for the deformation of metals, has been sent to us by Davy and United Engineering Company, Limited, Park Iron Works, Sheffield, 4. The publication contains three well-written and illustrated articles. The first is on "The Influence of Recent Rolling-Mill Research on Mill Practice and Design," by Mr. M. F. Dowding, M.A., A.M.I.Mech.E., the firm's engineering sales manager. The second article is entitled "Hydraulic Control Systems for Strip Handling Equipment," by Mr. J. H. Beard, A.M.I.Mech.E., the design engineer, and the third is a general account of the Davy-United plant installed in the Abbey and Newport Works of the Steel Company of Wales, Limited. The editorial panel responsible for the publication is headed by Mr. W. W. Franklin, M.I.Mech.E., director and chief engineer of the firm. The other members are Mr. M. F. Dowding, Mr. R. B. Sims and Mr. F. R. Smith. Copies of the new publication may be obtained on application to the publicity department at the Park Iron Works.



(8000) "ENGINEERING"

INDENTED BAR REINFORCEMENT FOR CONCRETE

Increased Strength from Cold-Working

The accompanying illustration shows the form of an indented bar for reinforcing concrete, first produced in Denmark and used extensively on the Continent and now to be made in the United Kingdom, under licence from the Danish patentees, by Guest, Keen and Nettlefolds (South Wales), Limited, at Cardiff. It is claimed that, with these bars, in common with all indented bars, although the number of cracks in the concrete on the tension side of a beam may be high, the width of the individual cracks is kept small as compared with those likely to occur with plain bars.

Before processing, the bar is a hot-rolled round bar with two parallel longitudinal ribs and a series of circumferential ribs spaced uniformly along the length. The indented bar is then subjected to a semi-continuous operation consisting of two types of cold working, applied simultaneously: a longitudinal stretching process which increases the strength throughout the whole section of the bar, and a twisting process which produces an additional increase in strength in the outer fibres. The tension and torsion processes give rise to the proprietary name of the bar, "Tentor," and produces the herringbone formation shown. It will be marketed by a member of the Guest, Keen and Nettlefolds Group, the Tentor Bar Company, Limited, 43 Upper Grosvenor-street, London, W.1.

The bar is rolled from mild steel in accordance with B.S.785, having an ultimate tensile strength of 28 to 33 tons per square inch. Cold-working increases the tensile strength of the bar and the yield point is eliminated; for such cold-worked bars, the stress corresponding to an elongation of 0·5 per cent. on the gauge length may be accepted as the proof stress. The finished bars have the following minimum proof stresses and ultimate strengths.

Dia. of bar, In.	Proof Stress, lb. per sq. in.	Ultimate tensile strength, lb. per sq. in.
$\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{7}{16}$ and $\frac{1}{2}$	75,000	86,000
$\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$ and 1	66,000	76,000

Tentor bars are processed in 130-ft. lengths, and bars in excess of the stock 40-ft. lengths can therefore be supplied if required.

The present B.S. code of practice, CP.114 (1948) limits the permitted working stress for cold-worked bars to half the guaranteed yield stress or 27,000 lb per square inch, whichever is the lesser. In shear bars, the stress must not exceed 20,000 lb. per square inch. In 1953, a committee convened by the Institution of Structural Engineers recommended, however, that the working stresses should not exceed half the proof stress or 33,000 lb. per square inch, whichever is the lesser. In slabs, however, the limit of 33,000 lb. per square inch could be increased to 37,000 lb. per square inch. A number of authorities, notably the London County Council, have been mentioned as using Tentor bars to the second set of limiting stresses.

THE "HOLPACK" PORTABLE AIR COMPRESSOR

In recording, on page 261, *ante*, the opening of the new London office of Holman Brothers, Limited, of Camborne, at 44 Brook-street, London, W.1, we referred to a demonstration of the "Holpack" portable air-compressor unit that they have recently placed on the market. Some further particulars of this unit are given below. It is supplied in two forms; in one, the tubular steel frame containing the compressor is mounted on the back of a Ferguson agricultural tractor, and in the other, on a Fordson tractor. In both cases, the tubular frame is attached to the tractor's hydraulic-lift mechanism so that it can be raised clear of the ground when travelling, and the drive to the compressor is from the power take-off of the tractor.

The Ferguson tractor may be fitted, at choice, with an engine to run on Diesel fuel, tractor vaporising oil (T.V.O.) or petrol. The compressor used in this instance is Holman Brothers' A.T.H.8 type, which, at the maximum speed, has a displacement of 84 cub. ft. per minute and delivers at a maximum continuous air pressure of 125 lb. per square inch. The volume of free air delivered per minute at 100 lb. per square inch is 70 cub. ft. The compressor has a differential piston 6½ in. and 5 in. in diameter, with a stroke of 4¼ in. The overall dimensions of the unit in its frame are 3 ft. 10 in. long, 3 ft. 8 in. wide and 4 ft. 10 in. high. The drive from the take-off shaft is through a lay shaft, carried in ball bearings, and a final V belt to the compressor.

The tubular frame is welded throughout and, at its forward end, has a three-point connection for attachment to the tractor links. It can be detached at will, in less than two minutes, so that the tractor is fully available for other work. The frame is mounted on rubber feet. A cylindrical receiver, of welded steel, is mounted within it, below the compressor, and is fitted with a safety valve, and the necessary service cocks for connections to compressed-air tools, etc. The capacity of the receiver is 1¼ cub. ft. A safety latch is provided in the tractor linkage to hold the unit securely in the elevated position when travelling.

The TA.13 compressor, which is fitted to the Fordson tractor, is a larger machine than the A.T.H.8, having a displacement, at maximum speed, of 130 cub. ft. per minute at a pressure of 125 lb. per square inch. The free air delivered at 100 lb. per square inch is 105 cub. ft. per minute. The diameters of the differential piston are 7½ in. and 5½ in., and the stroke is 4¼ in. The tubular frame has the same dimensions in plan as that for the A.T.H.8 compressor, but the height is 4 ft. 11 in.

In both types of compressor, the first stage of compression takes place in the top end of the cyclinder, from which the air is delivered through an intercooler to the annular space round the lower end of the piston, where it is raised to the final pressure. The valves are all of the multi-port plate type. If the demand for air is less than the output of the compressor, the inlet valves are automatically held open and the compressor runs light. The T.A.13 compressor has a forced-feed lubricating system; the A.T.H.8 compressor is splash-lubricated.

If desired, the Holpack unit can be fitted, at the front end, with additional hydraulically-operated equipment, such as a scraper blade, a bucket, a crane, or the elevating platform illustrated, which can be used to raise, for example, pneumatic tools up to a height of 15 ft. above ground level.

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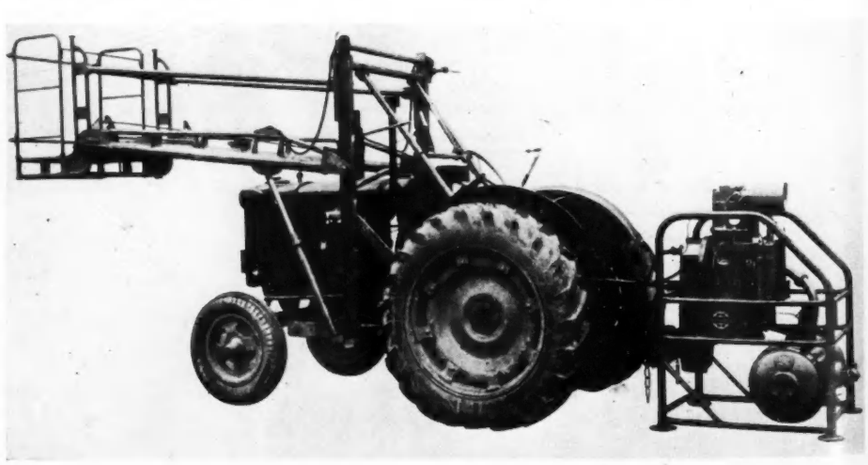
ROCK-WOOL FACTORY IN SCOTLAND

A factory for the production of a long-fibre rock wool was opened at Stirling on March 5 by the Earl of Home, Minister of State for Scotland. The new material is called Rocksil and its main constituents comprise dolomite from Duror, on the south side of Loch Linnhe, Argyll, and siliceous clay from Stirlingshire. It constitutes an inexpensive form of heat, cold and sound insulation material available in many forms for use in buildings, ships, cold-storage installations, aircraft, and road and railway vehicles. The factory covers a floor area of 100,000 sq. ft. and at present produces some 10,000 cub. ft. of fibrous material a day. The marketing of the product is being undertaken by William Kenyon and Sons, Limited, heat-insulation engineers, Dukinfield, Cheshire. The new factory is owned by the Cape Asbestos Company, Limited, 114 Park-street, London, W.1, which firm, it may be recalled, jointly with the Johns-Manville Corporation of America, last year installed plant in a factory at Germiston, Glasgow, to produce Marinite, an incombustible boarding material for ships' joinery work.



Fordson tractor fitted with "Holpack" air compressor and an elevating platform.

Labour Notes

GOOD RELATIONS IN INDUSTRY

Many aspects of the present industrial situation were raised during the debate in the House of Commons, on March 3, on a motion to reduce the estimates of the civil and revenue Departments and the Ministry of Defence. In his reply to the discussion, Sir Walter Monckton, the Minister of Labour and National Service, assured the House that there was no real basis for suggesting that there had been a catastrophic worsening of industrial relations.

Had it not been for the one-day token strike in the engineering and shipbuilding industries in December last, Sir Walter stated, the result in respect of industrial stoppages during 1953 would have been better than for many years past. Relations in industry could only be improved by the humdrum and worldly task of trying to build on foundations laid by leaders of the trade unions and employers' organisations during the last hundred years. In this connection, it should be realised, he said, that officials on both sides were fully conscious of their national responsibilities, and he added that he, personally, would like to pay tribute to their statesmanship.

In the midst of all negotiations, leaders of the two sides of industry had been willing to recognise the national need to continue good relations, and thereby to promote output and efficiency.

This attitude, maintained in spite of numerous difficulties, had led to the solution of many disputes and in it lay the nation's hopes for the future. If production and efficiency were increased by better relations in industry, everyone could rejoice in the higher earnings which would result in consequence.

SETTLEMENT OF DISPUTES BY ARBITRATION

Without in any way seeking to impose such procedure, Sir Walter said, he would like to see some form of voluntary arbitration introduced into the constitutional machinery for settling disputes, in trades where it did not at present exist. He emphasised, however, that he had no desire of interfering with the fundamental right of workpeople to withhold their labour, and that he had no thought of suggesting compulsory arbitration. At the same time, everything should be done to avoid unnecessary stoppages.

In effect, this meant that every honest and genuine attempt to settle disputes by existing negotiating machiney should be exhausted before other means were even considered. It also implied that industries should carefully examine their negotiating machinery, with a view to seeing whether anything could be done to improve it, not with a view to abandoning the right to strike, but with the object of making it unnecessary to resort to strikes.

The courts of inquiry into the disputes in the engineering and shipbuilding industries had brought great care and patience to their tasks, and it was to be hoped that their reports would do much to enhance respect for arbitration and encourage its use where such a process was available.

MINISTER'S INVITATION TO DISCUSS WAGE-POLICY PROPOSALS

Following his remarks in the House, Sir Walter wrote to the Trades Union Congress, the British Employers' Confederation, and the Boards of the nationalised industries, inviting their representatives to meet him to discuss the recommendations regarding the wider aspects of wage policy recently put forward by the courts of inquiry into the engineering and shipbuilding disputes. In their reports, the courts suggested that an impartial body should be set up to examine the complicated economic background which is involved in large-scale demands for wage increases.

There appears to be every likelihood that the Minister's invitation will be accepted, in due course, by all the organisations concerned and the British Employers' Confederation has already signified its willingness to take part. Some of the other bodies, however, may wish to explore the implications surrounding the courts' suggestions before accepting. The proposals outlined by the courts were in general terms only and the organisations approached by the Minister may well desire to have more precise information.

Some years ago, proposals by the Labour Government for the establishment of a permanent body to report on the economic issues involved in wage demands was firmly rejected by the Trades Union Congress.

TRADE-UNION DESIRE TO AVOID STOPPAGES

General support for the principle of voluntary arbitration in industrial disputes was given in a statement issued by the executive council of the Transport and General Workers' Union on Friday last.

The council state that they are impressed with the need to secure decisions in trade disputes by reference to arbitration, wherever possible, when a settlement cannot be reached otherwise. They point out that arbitration obviates the necessity of stoppages which would interfere with the economic prospects of the country, and they urge that the essential problem at the present time is to maintain the social services and the policy of full employment.

The council recognise that the country is entering a period of keen competition with other nations and that this will call for the greatest possible effort on the part of industry, in order that maximum productivity and the highest degree of efficiency may be attained. At the same time, they do not specifically refer to the introduction of provision for arbitration in the negotiating machinery of all industries, as suggested by Sir Godfrey Ince, the Parliamentary Secretary to the Minister of Labour, in recent speeches.

ENGINEERING-WAGE DISCUSSIONS TO BE RESUMED

Negotiations on the engineering wage claim of the Confederation of Shipbuilding and Engineering Unions are due to be resumed on Wednesday next. The decision of the Engineering and Allied Employers' National Federation to meet the trade-union leaders was reached at a meeting of the Federation's management board on March 3 and on the same day leading officials of the Confederation called at the Federation's offices to make the necessary arrangements.

Although discussions are to be renewed on the claim, neither side is committed to take up any definite attitude with respect to it, but both organisations will probably be willing to accept the 5 per cent. increase, tentatively put forward by the engineering court of inquiry, as the basis for their negotiations.

21 STRIKES AT ONE COLLIERY

Warnings about the large number of stoppages which had occurred during recent years at Caerau Colliery, Maesteg, Glamorganshire, were given by Mr. D. M. Rees, chairman of the South-Western Division of the National Coal Board, when he opened a new medical centre and pithead baths at the colliery on March 6. During the seven years or so since the nationalisation of the coal industry on January 1, 1947, Mr. Rees said, there had been no fewer than 21 strikes at the pit. Five of these strikes took place last year.

Conduct of that kind simply must not continue. If it did, Mr. Rees added, the Board would be compelled to take steps which would hurt only people engaged in the coal industry, in the long run. The Board hoped, however, that there would be few disputes in future and that strong measures on their part would not be required.

The new medical centre and baths are estimated to have cost the Board about £75,000. Referring to this, Mr. Rees said that if welfare amenities of that nature were necessary it did not matter what they cost to provide, but the men at Caerau must sit down and take stock of the position. They should then show that they were genuinely appreciative of what was being done for them, by striving to attain greater harmony and increased productivity.

MINERS STRIKE ABOUT ONE OVERMAN

A total of some 4,000 miners in the South Shields district were on strike at the beginning of this week owing to grievances against a fore-overman employed at Whitburn Colliery. Men at that pit ceased work at the end of February on account of what they claimed to be the tyrannical attitude of the overman concerned. They alleged that he had made " derogatory " remarks to a weighman and that he had " threatened " another weighman.

Representatives of the National Coal Board offered to hold an inquiry into the matter if the men would return to work. Officials of the Durham area of the National Union of Mineworkers have described the dispute as unofficial and have also appealed to the miners to return to work, in order that an investigation may take place, but the men involved have declared their intention of maintaining the stoppage until the overman has been suspended.

At a mass meeting of men belonging to the Harton and Westoe pits last Sunday, it was agreed that they would withdraw their labour as from last Monday, in support of the strikers at Whitburn. This left only the Boldon Colliery, in the South Shields group, still functioning. An official of the miners' lodge at that colliery stated that, in spite of the miners there remaining at work, they were in sympathy with the men at Whitburn.

With some 4,000 miners on strike, it is estimated that production in the coalfield will decline by some 25,000 tons a week.

VEHICLE-BUILDING EMPLOYEES SEEK ASSISTANCE OF MINISTER OF LABOUR

Efforts to end the deadlock which has arisen in the vehicle-building industry, in connection with the employees' demands for a substantial increase in wage rates, were made by the trade-union side on March 2. Officials of the three unions to which the men involved belong decided to approach the Minister of Labour with particulars of the dispute and to request his intervention.

It is understood that the Minister is to be asked to allow the Department's conciliation officers to mediate between the parties, and that there is no intention, at any rate for the present, of making a formal report of the dispute, under the provisions of the Industrial Disputes Order, in order that arbitration may take place.

Negotiations between the two sides have been in progress since November last year, but the employers have decided that they are not able to offer any increases in pay. Some 40,000 workpeople are concerned in this claim.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
"Industrial Photo-Electric Cells and Amplifiers," by D. H. Taylor; "Neon Signs—25 Years of Progress," by C. A. Jones; and "The Electrical Protection of Three-Phase Alternating-Current Motors," by S. H. Harding. Lighting Service Bureau, 2 Savoy-hill, W.C.2. Tues., Mar. 16, 7 p.m.
"The Institution of Electrical Engineers' Regulations," by J. J. Looker. South-West London Branch. Guild House, 32 Worple-road, Wimbledon, S.W.18. Wed., Mar. 17, 8.15 p.m.
CANTERBURY
Film Evening. Kent Branch. County Hotel, Canterbury. Thurs., Mar. 18, 8 p.m.
MANCHESTER
"Modern Lift Practice," by S. T. Hunt. Engineers' Club, Manchester. Wed., Mar. 17, 7.30 p.m.
PRESTON
"Outdoor Illuminations," by H. Carpenter. Offices, North-Western Electricity Board, Friargate, Preston. Wed., Mar. 17, 7.30 p.m.
SOUTHAMPTON
Film Evening. Polygon Hotel, Southampton. Wed., Mar. 17, 7.45 p.m.

Chemical Society

BANGOR
"Problems in the Chemistry of Polypeptides," by Professor H. N. Rydon. North Wales Branch. University College of North Wales, Bangor. Thurs., Mar. 18, 5.45 p.m.
BRISTOL
"Patent Specifications Regarded as Chemical Literature," by Dr. W. A. Sylvester. The University, Bristol. Thurs., Mar. 18, 7 p.m.
DUNDEE
"Technical Education," by Professor H. B. Nisbet. St. Andrews and Dundee Branch. University College, Dundee. Fri., Mar. 19, 7 p.m.
EDINBURGH
Various short papers. North British Station Hotel, Edinburgh. Thurs., Mar. 18, 7.30 p.m.

Diesel Engine Users Association

LONDON
"Preventive Maintenance from Breakdown Experience," by H. D. Adam. Caxton Hall, Victoria-street, S.W.1. Thurs., Mar. 18, 2.30 p.m.

Incorporated Plant Engineers

BRISTOL
"Steam Flow Measurement and Its Relation to Thermal Efficiency," by W. M. Barber. Annual General Meeting. Western Branch. Grand Hotel, Bristol. Wed., Mar. 17, 7.15 p.m.
CARDIFF
Discussion on "Modern Hand Tools and Mechanical Aids." South Wales Branch. South Wales Institute of Engineers, Park-place, Cardiff. Tues., Mar. 16, 7.15 p.m.
LIVERPOOL
Annual General Meeting. Merseyside and North Wales Branch. Radiant House, Bold-street, Liverpool. Mon., Mar. 15, 7.15 p.m.
MANCHESTER
Annual General Meeting. Engineers' Club, Manchester. Tues., Mar. 16, 7.15 p.m.
PETERBOROUGH
Open Discussion and Annual General Meeting. Eastern Gas Board's Offices, Church-street, Peterborough. Thurs., Mar. 18, 7.30 p.m.
ROCHESTER
Discussion on "Metal Spraying." Kent Branch. Bull Hotel, Rochester. Wed., Mar. 17, 7 p.m.

Institute of British Foundrymen

BRISTOL
"Light-Alloy Foundry Practice," by G. B. Partridge. Bristol and West of England Branch. Grand Hotel, Bristol. Sat., Mar. 20, 10.45 a.m.

Institute of Fuel

LOUGHBOROUGH
"Coal Science and Industry," by Dr. D. T. A. Townend. East Midland Section. Loughborough College, Loughborough. Fri., Mar. 19, 6.15 p.m.

Institute of Marine Engineers

LONDON
Discussion on "The Part the University Has to Play in the Training of the Marine Engineer," opened by A. W. Jones. Annual General Meeting of the Education Group. Fri., Mar. 19, 5.30 p.m.
BIRMINGHAM
"Heat Exchangers," by H. E. Upton. West Midlands Section. Imperial Hotel, Birmingham. Thurs., Mar. 18, 7 p.m.
LEEDS
Films on "Oil in Industry," introduced by T. M. Green. Kingston-upon-Hull and East Midlands Section. Metropole Hotel, King-street, Leeds. Thurs., Mar. 18, 7.30 p.m.

Institute of Metals

SHEFFIELD
"Some Factors Affecting Spring Design," by Dr. W. R. Berry. Sheffield Local Section. Mappin Hall, St. George's-square, Sheffield. Mon., Mar. 15, 7.30 p.m.
SWANSEA
Annual General Meeting. South Wales Local Section. University College, Singleton Park, Swansea. Tues, Mar. 16, 6.45 p.m.

Institute of Petroleum

LONDON
Symposium on "Metal-Working Oils." Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. Fri., Mar. 19, 2.15 and 5 p.m.

Institute of Refrigeration

LONDON
Discussion on "The Control of Relative Humidity in Cold Stores," opened by M. E. Anderson and G. Mann. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Tues., Mar. 16, 5.30 p.m.

Institute of Road Transport Engineers

LONDON
"Thin-Wall Bearings," by P. Holligan. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Thurs., Mar. 18, 6.30 p.m.
LEEDS
"Gas and Electric Arc Welding Applied to the Construction and Maintenance of Road-Transport Vehicles," by G. G. Musted. Yorkshire Centre. Hotel Metropole, King-street, Leeds, 1. Thurs., Mar. 18, 7.30 p.m.
WIGAN
"Carburation," by L. J. Spencer. North-West Centre. Victoria Hotel, Wigan. Wed., Mar. 17, 7.30 p.m.

Institute of Welding

CHATHAM
"Hydrogen versus Welding," by Dr. C. L. M. Cottrell. Medway Section. Sun Hotel, Chatham. Thurs., Mar. 18, 7.15 p.m.

Institution of Chemical Engineers

LONDON
"Mineral Dressing," by J. Holmes. Graduates' and Students' Section. Caxton Hall, Victoria-street, S.W.1. Fri., Mar. 19, 6.30 p.m.

Institution of Civil Engineers

LONDON
"Woodhead New Tunnel: Construction of a Three-Mile Main Double-Line Railway Tunnel," by P. A. Scott and J. I. Campbell. Tues., Mar. 16, 5.30 p.m.
LIVERPOOL
"Design of Foundations in Relation to Superficial Geological Deposits in the North-West Area," by B. M. Evans. North-Western Association. 9 The Temple, 24 Dale-street, Liverpool. Wed. Mar. 17, 6 p.m.
LOUGHBOROUGH
"Black Sluice Pumping Station," by F. H. Tomes and J. Finn. Midlands Association. Loughborough College, Loughborough. Wed., Mar. 17, 7 p.m.

Institution of Electrical Engineers

LONDON
"The Minimum-Moment-of-Error-Squared Criterion: A New Performance for Servo-Mechanisms," by Dr. J. H. Westcott; and "The Behavior of a Remote-Position Control Servo-Mechanism with Hard-Spring Non-Linear Characteristics," by Dr. J. C. West and P. N. Nikiforuk. Measurements Section. Tues., Mar. 16, 5.30 p.m.
Discussion on "The Training and Responsibilities of Marine Electrical Engineers," opened by G. O. Watson. Utilization Section. Thurs., Mar. 18, 5.30 p.m.
CHESTER
"The Co-Ordination of Insulation of High-Voltage Electrical Installations," by J. S. Cliff. Mersey and North Wales Centre. Town Hall, Chester. Mon., Mar. 15, 6.30 p.m.
NORWICH
"Modern Developments in Atomic Energy," by Dr. T. E. Allibone. District Meeting. Royal Hotel, Norwich. Mon., Mar. 15, 7.30 p.m.
OXFORD
"Modern Trends in Television," by G. G. Gouriet. District Meeting. Southern Electricity Board's Offices, 37 George-street, Oxford. Wed., Mar. 17, 7 p.m.
READING
"Contribution of Plastics to Cable Manufacture," by H. F. Wilson. District Meeting. George Hotel, Reading. Mon., Mar. 15, 7.15 p.m.

Institution of Engineers and Shipbuilders in Scotland

GREENOCK
"Modern Developments in the Design and Manufacture of Welded Pressure Vessels," by M. B. Hamilton and J. McIntyre. Joint Meeting with the Greenock Association of Engineers and Shipbuilders. The Lorne, Greenock. Tues., Mar. 16, 7.30 p.m.

Institution of Engineering Inspection

DUNDEE
"Aims and Objects of the National Physical Laboratory," by C. F. Watkinson. Royal British Hotel, Dundee. Wed., Mar. 17, 7.30 p.m.
MANCHESTER
"The Testing of Screw Threads," by A. Whitehead. North-Western Branch. Engineers' Club, Manchester. Thurs., Mar. 18, 7.30 p.m.

Institution of Locomotive Engineers

LONDON
"Experiences with British Railways Standard Locomotives," by E. S. Cox. Annual General Meeting. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Wed., Mar. 17, 5.30 p.m.

Institution of Mechanical Engineers

LONDON
Annual General Meeting. Open to corporate and non-corporate members of the Institution only. Fri., Mar. 19, 5.30 p.m.
"Atomic Energy Made Easy," by Sir Christopher Hinton. London Graduates' Section. Thurs., Mar. 18, 6.30 p.m.
BIRMINGHAM
Chairman's Address on "Mechanical Engineering in the Rubber-Tyre Industry," by Frederick Walker. Midland Branch. James Watt Memorial Institute, Birmingham. Thurs., Mar. 18, 6 p.m.
GLASGOW
"Operating Experiences with a 750-kW Gas Turbine," by G. B. R. Feilden. Scottish A.D. Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow. Mon., Mar. 15, 7.30 p.m.
LEEDS
"Some Problems in Lubrication and These Substances Called Additives," by A. Towle. North-Eastern A.D. Centre. The University, Leeds. Wed., Mar. 17, 7.30 p.m.
PORTSMOUTH
Repetition of Thomas Lowe Gray Lecture on "High-Temperature Turbine Machinery for Marine Propulsion," by Dr. T. W. F. Brown. Southern Branch. Municipal Technical College, Anglesey-road, Portsmouth. Wed., Mar. 17, 7 p.m.

Institution of Mining and Metallurgy

LONDON
"Some Grinding Tests with Spheres and Other Shapes," by G. Chad Norris; and "A Method of Predicting the Performance of Commercial Mills in the Find Grinding of Brittle Materials," by G. Lowrie Fairs. Geological Society's Apartments, Burlington House, Piccadilly, W.1. Thurs., Mar. 18, 5 p.m.

Institution of Production Engineers

CAMBORNE, CORNWALL
"Applications of Rubber in Engineering," by G. W. Trobridge. Cornwall Section. Camborne School of Mines, Camborne, Cornwall. Wed., Mar. 17, 7.15 p.m.
DERBY
Annual General Meeting and Film Evening. College of Art, Green-lane, Derby. Mon., Mar. 15, 7 p.m.
GLASGOW
"Noise and Vibration in Machinery," by Dr. A. J. King. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow. Thurs., Mar. 18, 7.30 p.m.
HUDDERSFIELD
"Designing a Cast-Iron Designer," by K. H. Collinson; and "Radial-Drill Time-Saving Devices," by T. P. N. Burness. Halifax Section. George Hotel, Huddersfield. Wed., Mar. 17, 7.15 p.m.
NEWCASTLE-UPON-TYNE
"Problems Involved in the Manufacture of Mineral Insulated Metal-Covered Cables," by J. E. I. Gaymer. North-Eastern Section. Neville Hall, Newcastle-upon-Tyne. Mon., Mar. 15, 7 p.m.
OXFORD
Annual General Meeting and Film Evening. Town Hall, Oxford. Tues., Mar. 16, 7.15 p.m.
SOUTHAMPTON
"Production Problems on the Javelin," by W. W. W. Downing. Polygon Hotel, Southampton. Thurs., Mar. 18, 7 p.m.

Institution of the Rubber Industry

LEICESTER
"Adhesion: Mainly Rubber to Textiles," by Dr. W. C. Wake. Bell Hotel, Leicester. Fri., Mar. 19, 7.30 p.m.

Junior Institution of Engineers

LONDON
"A Review of Plastics Piping," by B. T. A. Holland; and film on "Story of Tenite." Townsend House, Greycoat-place, S.W.1. Fri., Mar. 19, 7 p.m.
SHEFFIELD
"Developments and Future Possibilities of Electricity Generation," by Sir John Hacking. Royal Victoria Hotel, Sheffield. Mon., Mar. 15, 7.30 p.m.

Reinforced Concrete Association

LONDON
"Recent Research on Deformed Reinforcing Bars," by Dr. K. Hajnal-Konyi. Institution of Structural Engineers, 11 Upper Belgrave-street, S.W.1. Wed., Mar. 17, 6 p.m.

Royal Aeronautical Society

LONDON
"Development of the Spill-Flow Burner and Its Control System for Gas-Turbine Engines," by F. H. Carey. Tues., Mar. 16, 7 p.m.

Royal Institution

LONDON
"Sir Christopher Wren," by Dr. N. Pevsner. Fri., Mar. 19, 9 p.m.

Royal Meteorological Society

LONDON
Various Short papers. Wed., Mar. 17, 5 p.m.

The Royal Society

LONDON
"Surface Temperature of Sliding Solids," by F. P. Bowden and P. H. Thomas; and "The Strength Properties and Frictional Behaviour of Brittle Solids," by R. F. King and D. Tabor. Thurs., Mar. 18, 4.30 p.m.

Royal Statistical Society

LONDON
"Sampling Inspection and Statistical Decisions," by Professor G. A. Barnard. Research Section. London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. Wed., Mar. 17, 5.15 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"Dr. Mellor: His Life and Work," by Dr. A. T. Green. Grand Hotel, Sheffield. Tues., Mar. 16, 7.30 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

Association of Supervising Electrical Engineers, 54 Station-road, New Barnet, Hertfordshire. (BARnet 9141.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Diesel Engine Users Association, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, 3. (Blackfriars 6178.)
Institute of Fuel, 18 Devonshire-street, London, W.1. (LANgham 7124.)
Institute of Marine Engineers, 85 The Minories, London, E.C.3. (ROYal 8493.)
Institute of Metals, 4 Grosvenor-gardens, London, S.W.1. (SLOane 6233.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Refrigeration, Dalmeny House, Monument-street, London, E.C.3. (MINcing Lane 6851.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1. (SLOane 9851.)
Institution of Chemical Engineers, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. (Central 5181.)
Institution of Engineering Inspection, 28 Victoria-street, London, S.W.1. (ABBey 3794.)
Institution of Locomotive Engineers, 28 Victoria-street, London, S.W.1. (ABBey 6672.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Mining and Metallurgy, Salisbury House, Finsbury-circus, London, E.C.2. (MONarch 2096.)
Institution of Production Engineers, 36 Portman-square, London, W.1. (WELbeck 6813.)
Institution of the Rubber Industry, 12 Whitehall, London, S.W.1. (WHItehall 5012.)
Junior Institution of Engineers, 39 Victoria-street, London, S.W.1. (ABBey 6968.)
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Institution, 21 Albemarle-street, London, W.1. (HYDe Park 0669.)
Royal Meteorological Society, 49 Cromwell-road, South Kensington, London, S.W.7. (KENsington 0730.)
Royal Society, Burlington House, Piccadilly, London, W.1. (REGent 3335.)
Royal Statistical Society, 21 Bentinck-street, London, W.1. (WELbeck 7638.)
Sheffield Metallurgical Association, 15 Crescent-road, Sheffield, 7. (Sheffield 53674.)